VEDĀṄGA JYOTIṢA OF LAGADHA

IN ITS ṚK AND YAJUS RECENSIONS

WITH THE TRANSLATION AND NOTES OF

PROF. T. S. KUPPANNA SASTRY

Critically edited by

K. V. SARMA



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VEDĀṄGA JYOTIṢA OF LAGADHA

Edited and Translated

FOREWORD

The *Vedāṅga Jyotiṣa* of sage Lagadha is highly significant in the history of scienc in India, in the sense that it is the earliest full-fledged treatise on Indian astronomy As an adjunct to the Vedic lore, it forms a manual for the determination of rituals an sacrifices by the Vedic priest and for the preparation of a handy calendar for socia and religious events. The work is current in two recensions, one in 36 verses relate to the *Ṛgveda* and the other in 43 verses related to the *Yajurveda*, most of the verse in the two texts being common.

Several attempts have been made earlier to edit and interpret this popular tex However, the fact that the work was but a manual and not self-contained, and tha there was much to be learnt from tradition and practice towards a correct undei standing and interpretation of this cryptic text has made all the earlier attempt suffer from some inherent limitation or the other.

As such, it is a matter for gratification that the late Prof. T. S. Kuppanna Sastr took up the task of preparing a textual study and rational interpretation of the work He combined in himself erudition in Vedic tradition, knowledge of Indian astronom and equipped in modern mathematics. The draft he had left before he passe away in 1978 required to be edited and made press-worthy. Moreover, the Sanskri text needed to be critically edited from original manuscripts, and the necessar indices etc. prepared, to make the publication academically acceptable. This additiona work has been done in a scholarly manner by Dr. K. V. Sarma of the Kuppuswan Sastri Research Institute, Madras.

In placing before discerning scholars of Sanskrit and Science the ancient text o *Vedāṅga Jyotiṣa*, I have great pleasure in recording my sincere thanks to the sons o late Prof. Sastry for making available their father's erudite work for publication b the Indian National Science Academy and to Dr. K. V. Sarma for preparing thi scholarly edition.

Indian National Science Academy
New Delhi

S. K. Mukherjee
Vice-Chairman
National Commission for th
Compilation of History o
Sciences in India

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PREFACE

Vedāṅga Jyotiṣa (*VJ*), 'the astronomical auxiliary of the Vedas', of which a critical edition with translation and detailed exposition is being issued through this publication, is the earliest Indian text devoted exclusively to the treatment of astronomy. The work is traced back to the teachings of sage Lagadha (*c.* 1180 B. C.) and is current in two recensions exhibiting but minor differences, one pertaining to the *Ṛgveda* (*R-VJ*) and the other to the *Yajurveda* (*Y-VJ*) and called, respectively, *Ārca-Jyotiṣa* and *Yājuṣa-Jyotiṣa*. The work had, primarily, been intended as a manual for the determination of the times for rituals and allied purposes, for the use of the Vedic priests who supplemented it, as needed, with the concepts and practices imbibed by them by tradition. This latter aspect, coupled with the fact that the work is only a handbook and not a full-fledged self-contained treatise on the subject, has rendered the correct understanding of several passages in it difficult, for things not specifically defined in the text have to be known through traditional knowledge and practice. Particularly for this reason, the present translation and detailed exposition of the work with ample application of modern astronomy, by late Prof. T. S. Kuppanna Sastry should be welcome, for he combined in himself three qualities essential for the task, viz. sound scholarship in Sanskrit, good knowledge of Western astronomy and full understanding of the concepts and practices of traditional Hindu astronomy.

The Bharatiya Vidya Bhavan provided Prof. Sastry with a proper forum for placing his exposition before scholars for their adjudgement. The Bhavan organised in Bombay, on March 24-25, 1979, a 'Workshop on Ancient Astronomy' under its project on 'Ancient Insights and Modern Discoveries', a project which had been envisaged by them as a co-operative national endeavour to explore the possibilities of a meaningful correlation of ancient Indian insights and thoughts and the modern scientific discoveries and technical achievements. In fact, the *Vedas*, the *Upaniṣads*, the *Purāṇas* and several other works on various subjects in ancient languages would now seem to stand up to the more critical inquiry and examination of a modern scientific mind, as more and more discoveries of modern times are found to have relevant parallel references in the teachings of early Indian sages. The subject has been, for quite some time now, engaging the attention of scientists with a Sanskrit background and Sanskritists with a scientific background to make a meaningful correlation between the two. Towards the achievement of this laudable objective, the Bhavan has taken several steps including the establishment of contacts with scholars of the type mentioned above, institution of studies and researches of an inter-disciplinary nature and organisation of seminars and workshops towards providing a forum for discussions and mutual exchange of ideas in the different disciplines. It is pertinent to record that *Vedāṅga Jyotiṣa* and its present exposition was set out on the occasion of the first Workshop on Ancient Indian Astronomy organised by the Bhavan under its auspices as a part of its project noticed above. In fact, later, Prof. Sastry had expressed a desire to have his work published by the Bhavan, and the latter had included it in its publication programme. It was subsequently felt that it would be befitting if this work were to be

issued through the Indian National Science Academy, for two reasons, first, on account of this being a work on a scientific discipline and secondly the current year 1984-85 being the Jubilee Year of the Academy, a suggestion made on behalf of the Academy and accepted by the Bhavan. It is to be hoped that this decision would be acclaimed by the scholarly world.

The *Vedāṅga Jyotiṣa*, being just a handbook, does not present its contents always in a systematically arranged manner as is the case with later texts on astronomy. As a result, topics on the same subject often find themselves distributed in different places in the work and vice versa. In order to enable the understanding of the astronomical knowledge contained in the work in a compact way, the Text, Translation and Exposition in this publication are presented in the undermentioned manner.

In Part A, the *Ṛk* and *Yajur* recensions, *R-VJ* and *Y-VJ*, of the *Vedāṅga Jyotiṣa* have been separately edited from a critical point of view on the basis of 20 manuscripts including those whose readings are recorded by A. Weber in his 'Über den Vedakalendar, namens *Jyotisham*', (*Abh. Berliner Ak. der Wiss*, 1862, 1-130). The corruptness of certain passages have necessitated emendations which have been so couched as to suit the available lettering in the manuscripts, the context and the meaning, and have been placed within brackets The justification of the emendations have been made later in the exposition of the verses in Part B of this publication.

The undermentioned manuscripts have been collated towards constituting the Critical Text of *VJ* given in Pt. A. The abbreviations used herein are: DNg.=Devanāgarī, Gr.=Grantha, Tel.=Telugu; Pl.=Palmleaf; Pr.=Paper; and Cm.=Complete.

Ṛk-Vedāṅga Jyotiṣa

A and *B*. No. 1505, *Verseichniss der Skt. und. Pkt. Hand. der Konig. Bibl. zu Berlin*, by A. Weber. Ng. Pr. Cm. 8 ff.
C. No. 372, op. cit. Ng. Pr. Cm. 4 ff. Dated Saṃ. 1834 (A.D. 1779).
D. Wilson 503 in *Catalogi Cod. Man. Bibl. Bodleiane*, by T. Aufrecht. Ng. Pr. Cm. Dated Saṃ. 1849 (A.D. 1793).
E. No. 373, in Weber, op. cit. Ng. Pr. Cm. 4 ff.
F. Modern copy procured by A. Weber and used in his edition.
G. No. D-1027 of the Govt. Or. Mss. Lib., Madras (GOML), Gr. Pl. Cm. 4 ff.
H. No. R-6018(b) of GOML. Gr. Pl. Cm. 2 ff.
I. No. D-18726 of GOML. Tel. Pr. Cm. 5 pages.
J. No. D-14097 of GOML. Tel. Pl. Cm. 3 ff.
K. No. D-1028 of GOML. Tel. Pl. Cm. 3 ff.
L. No. R-4082(d) of GOML. Tel. Pl. Cm. 3 ff.
M. No. D-17880 of GOML. Tel. Pl. Cm. 2 pages.
N. No. 67034 of the Adyar Library and Res. Centre, Madras. Tel. Pl. Cm. 2 ff.

Yajur-Vedāṅga Jyotiṣa

A. No. 1505, Weber, op. cit., with the commentary of Somākara. Ng. Pr. Cm. 78 ff.
B. No. 374, Weber, op. cit. Ng. Pr. Cm. 5 ff. numbered 4 to 8.
C. No. 375, Weber, op. cit. Ng. Pr. Cm. 6 ff. numbered 4 to 9.
D. No. Wilson 502-a, Aufrecht, op. cit. Ng. Pr. Cm. Dated Saṃ. 1696 (A.D. 1639).
E-F. Modern copies procured by Weber and used in his edition.

Part B is devoted to the Translation and the Exposition of the *VJ* and to the demonstration of the principles and practices involved by means of worked out examples. Herein the *VJ* verses have been classified into five Sections according to the topics dealt with by them. Since most of the verses in the two recensions are common, both are translated and explained together. Thus against the common verses would be given both the *R-VJ* and *Y-VJ* references, while verses occurring in only one of the recensions will have the references only to the respective recension. The following are the sections under which the verses have been classified: (*i*) Benediction and Valediction; (*ii*) Measures of Time, Asterisms etc.; (*iii*) Fundamental and derived *Yuga* constants; (*iv*) *Tithi*, *Nakṣatra* etc. of certain special days; and (*v*) Daily *Tithi* and *Nakṣatra* and their risings and settings. The rules for the calculation of the days, *parvas*, daily *tithis* and *nakṣatras* included in the last section are not very obvious and the terms used are mostly undefined that these verses have been most difficult to understand. Successive scholars who have attempted to unravel the meaning and application of these verses have been successful in different degrees and most of them have left several of the verses as incomprehensible. The length to which some scholars, especially from the West, have been baffled as to have expressed themselves in a most unbecoming manner, with ignorance turned to anger and anguish, might be illustrated from a statement of D. W. Whitney, when he says: "And when we come to add that the Jyotisha (*VJ*) has no definable place in Sanskrit literature, or relation to the Vedic ceremonial ...we shall see that this famous datum, which has seemed to promise so much, has caused so much labour and discussion, and is even yet clung to by some scholars as the sheet-anchor of ancient Hindu chronology, is nothing but a delusive phantom." (cf. his *Oriental and Linguistic Studies*, Second Series, New York, 1874, p. 384). May be, Prof. Sastry's rational interpretation of these enigmatic verses would induce this Western Orientalist turn in his grave. It goes to the credit of Prof. Sastry to have tackled the *VJ* in its entirety and to have been able to give satisfactory interpretations to all its verses, which, perhaps, is the most convincing of what have been given thus far by scholars who have attempted the task.

I might close this Preface with a personal note. It would seem that a wish expressed by Prof. Sastry, more than five years ago, finds fruition at this moment. In a letter dated March 3, 1979, he wrote to me: "Dear Sharma, ... Regarding the Vedanga edition, Dr. Abraham (of the Christian College, Madras) and Dr. Ansari (of the A. M. University Aligarh), asked me to get it published by the Bharatiya Vidya Bhavan.... *Otherwise, I would have wished it to be done by you, because if I simply send the manus-*

cript to you, you would have done everything else." Having the highest regard for Prof. Sastry and appreciation for the confidence that he had been placing on me during our close academic relationship for nearly 30 years, I am happy that my association which he had wished for in the edition and publication of the *Vedāṅga Jyotiṣa* has ultimately been fulfilled, though under circumstances not envisaged by him.

The present Translation and Notes of *Vedāṅga Jyotiṣa* has been prepared on the basis of the draft thereof and the related papers left by Prof. Sastry with his son Dr. T. K. Balsubramanian, Scientist, BARC, Bombay, who placed them in my hands, for their edition and publication through a common friend, Shri S. Hariharan, Executive Director, LIC, Bombay, who, besides, was an admirer of Prof. Sastry. I am thankful to both these friends in the matter. My thanks are due also to the Bharatiya Vidya Bhavan and the Indian National Science Academy, the former for agreeing to publish the book, in the first instance, and the latter for actually publishing the work under their auspices during their Golden Jubilee Year.

Adyar Library and Research Centre, Madras,
Śrāvaṇa-pūrṇimā, The Sanskrit Day,
August 11, 1984

K. V. SARMA

INTRODUCTION

1. *Astronomy of the Vedic Saṃhitās*

The *Vedāṅga-Jyotiṣa* (*VJ*) belongs to the late Vedic age. Even during the time of the early *maṇḍalas* of the *Ṛgveda* astronomical information necessary for the day to day life of the people, like the knowledge of the seasons for sowing, reaping etc., had been acquired, as among all ancient peoples. Information required for the religious life of the people, like the times of full and new moons, the last disappearance of the moon and its first appearance etc., necessary for the monthly rites like the *Darśapūrṇamāsa* and seasonal rites like *Cāturmāsya*, had also been acquired.[1] The names of the moon's asterisms (27) were known and used to indicate days.[2] There are vestiges in the shape of the Vedic legends and names of asterisms to show the antiquity of particular *mantras*. For instance, *Agrahāyaṇa*, an old name for the asterism *Mrgaśīrṣa*, meaning 'beginning of the year', points to the fourth millennium B C. when the sun was there at the vernal equinox. The *Rohiṇī* legends point to a time in the late *Ṛgvedic* period when the point shifted to the asterism *Rohiṇī*.[3] The later sacrificial session called *Gavāmayana* was especially designed for the daily observation of the movements of the sun and of the disappearance of the moon, and this must have given the priests sufficiently precise knowledge about the astronomical elements. We have evidence to show that even knowledge of a special kind, like the *saros* of the Greeks, for predicting the solar eclipse, was possessed by the priests of the Atri family.[4]

The above type of knowledge improved with time, so that in the *Yajurveda* period we can say with certainty that the following was well known: The solar year was known to have 365 days and a fraction more, though it was roughly spoken of as having 360 days, consisting of 12 months of 30 days each. Evidence for this is found in the *Kṛṣṇa-Yajurveda: Taittirīya Saṃhitā* (*TS*) 7.2.6, where the extra 11 days over the 12 lunar months, Caitra, Vaiśākha etc., totalling 354 days, is mentioned to complete the *ṛtus* by the performance of the *Ekādaśarātra* or eleven-day sacrifice.[5] *TS* 7.1.10 says that 5 days more were required over the *Sāvana* year of 360 days to complete the seasons, adding that 4 days are too short and 6 days too long.[6] Further, five years were found to form a *yuga*, the names of the years thereof being *Saṃvatsara*, *Parivatsara*, *Idāvatsara*, *Anuvatsara* and *Idvatsara*.[7] This *yuga* was used to reckon time, as seen from such statements as 'Dīrghatamas, son of Mamata, became old even in his tenth *yuga*', i.e. between the age of 45 and 50.[8] Even earlier, the two intercalary months, called *Aṃhaspati* and *Saṃsarpa*, required to complete the *yuga*, were known, as seen from the statement *vedo māsā dhṛtavrato dvādaśa prajāvataḥ/vedā ya upajāyate//* (*RV* 1.25.8).

The six *ṛtus* in the solar year, with the names of the twelve tropical months, are given by the statement:

> *Madhuśca Mādhavaśca Vāsantikāvṛtū, Śukraśca Śuciśca Graiṣmāvṛtū, Nabhaśca Nabhasyaśca Vārṣikāvṛtū, Iṣaśca Ūrjaśca Śāradāvṛtū, Sahaśca Sahasyaśca Haimantikāvṛtū, Tapaśca Tapasyaśca Śaiśirāvṛtū* (*TS* 4.4.11.1; *Vājasaneyi Saṃhitā* (*VS*) 13.14).

It might also be seen that the sacrificial year commenced with *Vasanta* (spring). It had also been noted that the shortest day was at winter solstice when the seasonal year *Śiśira* began with *Uttarāyaṇa* (*Kauṣītaki Brāhmaṇa*, 19.3) and rose to a maximum at the summer solstice.

2. *Datable Vedic passages*

It was observed that the moon came back to the same position in the zodiac once in about 27 days and that each day was marked by the asterism or asterismal group (*nakṣatra*) near which the moon was seen, resulting in calling the asterism as the day's *nakṣatra*, from which the 27 asterismal segments of the zodiac came into use. The names of these with their presiding deities are enumerated in the *Yajurveda*, beginning with *Kṛttikā*, where the spring equinox was situated at that period. The thirteen and a half *nakṣatras* ending with *Viśākhā*, situated in the northern hemisphere, were called *devanakṣatras*, while the thirteen and a half others ending with *Bharaṇī* were called *yamanakṣatras*, as seen from the passage: *Kṛttikāḥ prathamam, Viśākhe uttamam, tāni deva-nakṣatrāṇi. Anurādhāḥ prathamam, Apabharaṇīr uttamam, tāni yama-nakṣatrāṇi* (*Taitt. Brāhmaṇa*, 1.5.2.7). Incidentally, this would give the age of the observation as *c.* 2300 B.C.

Another statement about the *Kṛttikās* points to even an earlier period: Vide the passage: *etā* (*Kṛttikā*) *ha vai prācyai diśo na cyavante, sarvāṇi ha vai anyāni nakṣatrāṇi prācyai diśaś cyavante* (*Śatapatha Brāhmana*, 2.1.2.3). This means that the asterismal group *Kṛttikā* never swerve from the east, while the others do. The meaning is confirmed by Sāyaṇa's commentary. This points to *c.* 2950 B.C.

A far later observation is reported in the *Maitrāyaṇīya Brāhmaṇa-Upaniṣad*, 6.14, to the effect that the winter solstice was at the mid-point of the *Śraviṣṭhā* segment and the summer solstice at the beginning of *Maghā*. This points to *c.* 1660 B.C., a little before the period of the *Vedāṅga Jyotiṣa*.

Even regular astronomers are mentioned by expressions like *prajñānāya nakṣatradarśam* (*YV-Vājasaneyi Saṃhitā*, 30.10; *Tait. Br.*, 3.4.4.1), and *yādase gaṇakam* (*YV-Vāj. Saṃ*, 30.20; *Taitt. Br.*, 3.4.15.1). A *Nakṣatra-vidyā* (Science of the stars) is mentioned in the *Chāndogya Upaniṣad*, 7.1.2.4; 2.1; 7.1. These references would give an idea of the astronomical knowledge which had been acquired before the time of *VJ*, on the basis of which the *VJ* has to be adjudged.

3. *Text of the Vedāṅga Jyotiṣa*

Of the extant Indian astronomical texts, the *VJ* is the earliest. The astronomical matter forming the basis of the work is of one Lagadha, but the classical language employed in the work as current now would indicate that the original must have been redacted by a later person belonging to the last centuries B.C. The same system as mentioned in the *YJ* is seen in the *Mahābhārata*, the earlier astronomical *saṃhitās* like that of Garga etc., and the *Paitāmaha Siddhānta* condensed by Varāhamihira (*VM*) in his *Pañcasiddhāntikā* (*PS*). The *VJ* has come down in two recensions, one belonging

to the *Ṛgveda* (*R-VJ*) and the other, which is later, larger and more advanced in its methods, to the *Yajurveda* (*Y-VJ*), though their basic content is almost the same. Later than these came the *Atharvaṇa Jyautiṣa*, attached to the *Atharva Veda*, called so just for the sake of uniformity. While the first two are astronomical, the third deals with the *Muhūrta* branch of astrology. While the first two purport to be based on Lagadha's science, the *Ātharvaṇa* says that it was taught by Pitāmaha to Kāśyapa.

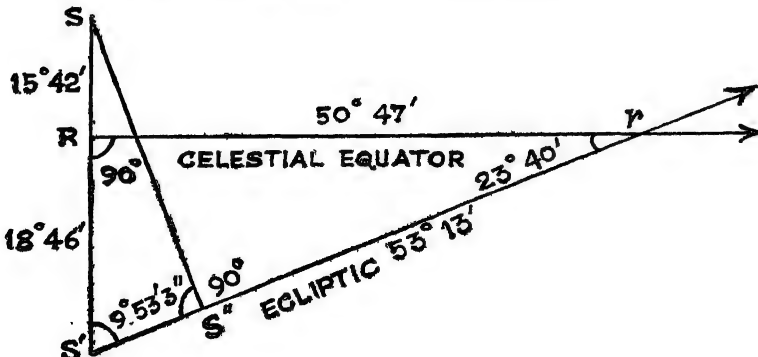
4. *Date of the Vedāṅga Jyotiṣa*

Verses 6, 7 and 8 of the *Yajur-Vedāṅga Jyotiṣa* (*Y-VJ*) show that at the time of Lagadha the winter solstice was at the beginning of the asterism *Śravisṭhā* (Delphini) segment and that the summer solstice was at the mid-point of the *Āśleṣā* segment. It can be seen that this is the same as was alluded to by Varāhamihira in his *Pañcasiddhāntikā* and *Bṛhatsaṃhitā*. Since VM has stated that in his own time the summer solstice was at *Punarvasu* $\frac{3}{4}$, and the winter solstice at *Uttarāṣāḍhā* $\frac{1}{4}$, there had been a precession of $1\frac{3}{4}$ stellar segments, i.e. 23° 20″. From this we can compute that Lagadha's time was 72×23 1/3=1680 years earlier that VM's time (*c.* A.D. 530), i.e. *c.* 1150 B.C. If, instead of the segment, the group itself is meant, which is about 3° within it, Lagadha's time would be *c.* 1370 B.C.

5. *Verification of the date of Lagadha*

The date arrived at as above can be confirmed by the *Sūryasiddhānta* and the *Siddhānta Śiromaṇi* which give 290° polar longitude and 36° polar latitude to *Śraivṣṭhā*. From this, the actual longitude of *Śraviṣṭhā* got is 296° 15′. Since the *siddhāntas* use the fixed zodiac beginning with the vernal equinox of *c.* 550 A.D., and the winter solstice of this is 270°, there has been a precession of 296° 15′ *minus* 270°=26° 15′. Since $26\frac{1}{4}$×72=1890 years, the wanted time is 1890 years, before A.D. 550, i.e. *c.* 1340 B.C., being the same as the above, the small difference being observational.

We can also calculate the time directly by comparing the position of *Śraviṣṭhā* (Q Delphini) at the time when the winter solstice was 270°, with its position in 1940 A.D. (Rt. as. $20^h\ 36^m\ 51^s$=309° 13′, and declination 15° 42′ N). In the figure: The obliquity is about 23° 40′, *r* is the vernal equinox, *S* is *Śraviṣṭhā* and *R* its Rt. as. position.



Rr=360°—Rt. as.=50° 47′. *RS* is the declination=15° 42′. *RŚ* is the continuation of *SR* up to the ecliptic. Now:

(*i*) From the rt. angled spherical triangle *RrŚ*, it can be calculated that *RŚ*=18° 46′; *Śr*=53° 13'; and angle *Ś*=75° 17′.

(*ii*) From the rt. angled spherical triangle *SŚS″*, *ŚS″*=9° 53′3″, *S″* being the celestial longitude of *S* in A.D. 1940. It was 270° at the time required. Therefore, the precession is 360°—53° 13′—270°+9° 53′=46° 40′. Multiplying by 72, the time is 3360 years before A.D. 1940, i.e. *c.* 1400 B.C. If the beginning of the segment is meant and *Śraviṣṭhā* is about 3° inside, it is *c.* 1180 B.C. Since all these is subject to small errors of observation, it would be noted that we have got from all almost the same date for *VJ*.

One may wonder why so much trouble is taken to prove this. It is because that late L.D. Swamikannu Pillai has fixed the date *c.* 850 B.C., after a lot of argument, in his *Indian Ephemeris*, vol. I, Pt. i. pp. 444-45. Trusting in the so-called *Dṛk-gaṇita Pañcāṅga* of the Kumbhakonam Mutt, in South India, he has accepted the precession in 1916 as about 22½, with the spring equinox of about A D. 550 as the first point of the fixed zodiac. This would give 22½×72=1620 years earlier than 1916 for the spring equinox of VM's time, i.e. *c.* A.D. 300. This difference of about 250 years is taken by Swamikannu Pillai as VM's observational error, since he has taken that VM's date is correctly A.D. 550. Proceeding from this, he argues that in about 1600 years there is an observational error of 250 years, and "allowing the same proportion of error for the previous epochs, the antiquity of *Vedāṅga Jyotisa* observation, ... may also be reduced by 250/1620, i.e. by 2/13; in other words, from 3300 years before now to 2792 years before now, i.e. from B.C. 1400 to B.C. 850." (ib., p. 445).

Note here the strange lapse on the part of Pillai, taking that the error of observation depends upon the time elapsed. On the other hand, it depends on the instruments used and the 'personal equation', and not "proportiontate" to the time elapsed. He has confused this with the error in the cycles derived from previous observations, which error alone can accumulate with time.

Further, VM's observation was remarkably good. The vernal equinox was at the first point of the Indian zodiac, defined as being about 10′ east of the 'Junction star' of *Revatī*, which, from its co-ordinates given by the *siddhāntas*, must be identified with Zeta Piscium. All *siddhāntas*, explicitly or implicitly, take the precession to be zero at about this period and the vernal equinox was situated here at this period. So there was very little error of observation on the part of VM, which is a remarkable thing. If so, the precession at 1916 should be about 19° since (1916—550)÷72=19. How, then, has this 22½° precession arisen in the Tamil *Dṛk* almanac, it may be asked. This is how it has happened. All Hindu *siddhāntas* give a sidereal year in the neighbourhood of 365-15-31-30 days, which is about 8½ *vināḍis* more than the correct sidereal period of the Sun. Since the Sun is taken to return to the first point of the Hindu Zodiac after each sidereal year, the first point of the Hindu zodiac itself has a precessional

movement (though taken to be fixed), and, reckoned from this point, the rate of precession would be not the real 50″. 25, but 50″. 25 *plus* 8″. 5=about 59″. This error of 8″. 5 has accumulated up to the time of the appearance of the Tamil *Dṛk* almanacs at the end of the last century, and when the Kumbhakonam Mutt *Pañcāṅga* originated about a hundred years ago, the error had accumulated to more than 3°. In order to fall in line with the *siddhāntic* new year day and thus avoid popular outcry if the correct *c.* 19° precession were to be adopted, in which case the new year would have to be begun three days earlier, and also to avoid certain difficulties with the *dharmaśāstras*, this *Dṛk Pañcāṅga* tacitly adopted a precession of 19° *plus* 3°=22°, to hide the fact that the *Dṛk* system was an innovation and to create the impression that it had been in existence from time immemorial. This had led Pillai to this error in judging the period of the *VJ*.[9]

6. *Contents of the Vedāṅga Jyotiṣa*

The system of the *VJ* is the same as that taught in the *Gargasaṃhitā* of the *Saṃhitā* period, being the immediate centuries before Christ and the next following, *Paitāmaha Siddhānta* condensed in the *PS* and the Jain works like *Jyotiṣakaraṇḍa* and *Sūryaprajñapti*. The only difference is that the *Paitāmaha* gives a rule for the *Vyatīpāta-yoga* and the Jain works have brought down the winter solstice from *Śraviṣṭhā* to *Śravaṇa*, and included *Abhijit* (Vega) as closing the zodiac, giving it a small segment at the end. All give the five-year *yuga* of 1830 days with 62 synodic months in it. Everything else, like the 67 lunar sidereal periods etc., can follow from these three given items. The *Paitāmaha* instructs that the *nakṣatras* and *tithis* are to be calculated from the days elapsed in the *yuga* using the unitary method. The Jain works give the days and the *nakṣatras* in a *parva*, from which they are to be calculated for the other *parvas* and days.

The *VJ* states in detail that in the *yuga* there are 5 solar years, 67 lunar sidereal cycles, 1830 days, 1835 sidereal days, 62 synodic months, 1860 *tithis*, 135 solar *nakṣatras*, 1809 lunar *nakṣatras* and 1768 risings of the Moon, all derivable from any three principal elements. It also mentions that there are 10 *ayanas* and *viṣuvas* and 30 *ṛtus* or seasons, and the *nakṣatras* and *tithis* of these are enumerated, their number being small. But the other things sought to be given, like the daily *nakṣatras* and *tithis* with their ending moments, the hour-angle of the Sun at the ends of the *parvas* and *tithis*, the hour-angle of *Śraviṣṭhā* with the *lagnas*, which are too numerous to be enumerated, have been given by ingenious rules that enable them to be calculated mentally day by day, as we want them. It is these rules that have baffled interpreters, since they are couched in archaic, technical and terse language, and the purpose of each cannot be seen easily and the terms used are not generally defined. The day is divided into 124 *bhāgas* or parts, so that the ending moments of the *parvas* and *tithis* can be given in whole units. The day is again divided into 603 units called *kalās*, so that the duration of the lunar *nakṣatras* is given in whole units as 610 *kalās*. The *nakṣatra* is divided into 124 *aṃśas* so that the *nakṣatras* passed at the ends of the *parvas* may be expressed in whole *aṃśas*. A table of the division of time is given, beginning from *gurvakṣara*

or the double *mātrā* or long syllable, to the day, passing on to the *yuga*. The practical way of measuring time is mentioned as the time taken by a specified quantity of water to flow through the orifice of a specified clepsydra, as one *nāḍikā* or 60th part of a day.

7. *Accuracy of the Vedāṅga Jyotiṣa*

We shall now proceed to examine the accuracy of the system, a much discussed affair. The *VJ* says that there are 1830 civil days in the *yuga*, in which there are five solar sidereal years and 62 lunar synodic months. This gives 366 days for the year while it is really 365¼ days, known in the Vedic period before, as we have seen. Also, it must have been known, even at that period that 62 synodic months take almost a day more than the 1830 given, because even at the end of one *yuga*, the *amāvāsyā* (new moon) must have been observed to occur on the day next to the 1830th. Observation at the end of the next *yuga* would have shown this unmistakably, since on the last day of the *yuga* the Moon would have been observed to be well up in the sky at sunrise, showing the day to be *caturdaśī* or even *trayodaśī*, so that the *amāvāsyā* would occur one or even two days later.[10] The priests, whose duty it was to observe the last disappearance of the old Moon and the first appearance of the new Moon, could never have failed to notice this, for there was *prāyaścitta* (penalty propitiatory rites) for transgression either way (see below, verse 12 and notes thereon).

Then, why this apparently absurd system? The answer is that it was meant primarily to provide a civil calendar, where convenience of division and ease of calculation is important. The 1830 days period is divisible by 5, giving 366 days for the year. This is divisible by 6, giving 61 days for each *ṛtu* (season). The *ayana* has 183 days. The two intercalary months, over the 60 normal months can come, one at the end of the 5th *ayana* and the other at the end of the 10th. The difference from actuality is already there, because only the computation of the Mean Moon and the Mean Sun was known, which itself could give an error of more than half a day. So the rules for computing the various items like *nakṣatras* can give only approximate results. But the religious calendar required correct results, and this civil calendar intended for the day to day life of the people could serve only as a frame-work to guide the religious calendar. Certainly the priests must have framed rules by long observation to get tolerably correct positions, so as to avoid the penalty laid down by the *śāstras*, as mentioned above. For one thing, a day could have been tacitly added to the *yuga* after its end, as suggested by many, (even as we do every fourth year to get the leap year), and not counted in the calculation, to make up the 62 synodic months, so that the most patent discrepancy could be avoided. H. Krishna Sastry Godbole, writing about the Vedic calendar in 1884, suggested this. As this would amount to allowing the error to accumulate to one day before correction, some suggest that the uncounted day might have been placed at the end of the 5th *ayana*, i.e. after the first intercalary month. Tilak suggests that it was done at the end of the 93rd *parva* and adds that it is actually instructed by verse 12. I think he is not correct (cf. the verse).

But there is another type of error that will accumulate in course of time. 62 synodic months is exactly 1830·8965 days. So, the correct Mean Sun would be 4°54′ in advance of *Śraviṣṭhā*, each *yuga*. It will accumulate to 30° in 30÷4·54 *yugas*. To bring the Sun and the Moon back to *Śraviṣṭhā*, one intercalary month will have to be dropped after 6 *yugas* and another intercalary month after 7 *yugas*, and this has to be repeated. The priests could have found this rule by experience and used it. But it must be noted that it is not even necessary to know this rule to drop the intercalation, because mere observation of the Moon in the *Śraviṣṭhā* region of the sky would have shown this, for this must have been the rule during the Vedic times (as the Muslims do even today, by observing the crescent Moon) to find the need for an intercalation, for this is independent of the knowledge of the exact periods of cycles.

But, still, in course of time, the winter solstice itself would move from *Śraviṣṭhā* to *Śravaṇa* and so on, at the rate of about one *nakṣatra* in 1000 years, owing to the precession of the equinoxes, and this correction must be done to know the correct seasons. It has already been mentioned that the *Sūryaprajñapti* and other works actually placed the winter solstice at the beginning of *Śravaṇa*. But one thing is certain. Long after the time of Lagadha, the system of the *VJ* was followed in India as seen from the *Mahābhārata*, the *Arthaśāstra*, *Gargasaṃhitā* and the *Paitāmaha Siddhānta*, first in all parts, and then at least in some parts, for almanac making, and that is why it is described in the *PS* as one of the systems in vogue, though crude. But by then it had come to be linked with the luni-solar year to prevent accumulation of error, as we have already mentioned.

8. *Modern studies on Vedāṅga Jyotiṣa*

The above discussion would show how wrong and unjustified Whitney was, when he remarked: "The so-called Vedic astronomical manual (*VJ*) whose first object seemingly ought to be to give rules on such points (as *amāvāsyā* etc.) is mostly filled with un-intelligible rubbish, and leaves us in the lurch as regards valuable information." This remark is born of frustration, for, if un-intelligible, how does he decide it is rubbish?

The *VJ* attracted the attention of the early Indologists like Sir William Jones and Colebrooke, especially the two verses placing the winter solstice at *Śraviṣṭhā*, which could help in determining Vedic chronology. Later, Capt. Jervis, who was investigating the Indian measurement of time, noticed it in 1834. Prof. A Weber was the first to bring out an edition of both the recensions of *VJ* with the different readings from the manuscripts available to him. But excepting for a few simple verses in the First and Second Sections of the edition presented hereinbelow, few could interpret the main body of the verses. It was in 1877 that Thibaut in his article entitled, 'Contributions to the explanation of the Jyotisha Vedanga' published in the *Journal of the Asiatic Society of Bengal* (47.i.411-37) could decipher a few of the difficult verses, leaving out several verses, including 11, 13-17, 19-23, 25-27 and 41 of the *Y-VJ* untouched. His knowledge of astronomy and adequate knowledge of Sanskrit helped

to interpret the other verses, in spite of the obscure terms and the apothegmatic language, because the meaning of these could be guessed if what they are driving at is known. Then, in 1884, H. K. Godbole tried to tackle the problem of the correct religious calendar to be got from the approximate civil one. Next, S. B. Dikshit, in his *Bhāratīya Jyotiṣa-śāstra* in Marathi (Poona, 1896) brought his excellent knowledge of Hindu astronomy to bear on the *VJ* and interpreted some more uninterpreted verses. But the more important verses were left untouched by him. In 1907, Lala Chote Lal, Executive Engineer, W.P., brought out a full-fledged edition, adopting the pseudonym 'Bārhaspatya', giving his own interpretation to all the verses, reprinting them from the *Hindusthan Review*, wherein they had appeared serially. However, in many places his meaning is not clear in spite of his long explanations. Neither has he mentioned what was being done nor has he given examples. At about the same time, M. M. Sudhakara Dvivedi of the Queen's College, Banaras, who had edited the *PS* in collaboration with G. Thibaut, edited the *VJ* with an old Sanskrit commentary by Somākara, in which he noticed many of the interpretations of 'Bārhaspatya', some of them as corrected by him. However, his peculiar way of emending the verses drastically has affected this edition. Then again, his presumption of the use of *bhūtasaṅkhyā* is unwarranted. But even where he agreed, he has tried to show off his superior knowledge of Sanskrit by giving his own 'better' interpretation. These exasperated 'Bārhaspatya' to such an extent, that he issued an Appendix criticising Sudhakara Dvivedi right and left. One very good service that 'Bārhaspatya' has done is to append a critical edition of both the recensions of the *VJ*, to his edition of the work.

The renowned Indian patriot and freedom fighter, B.G. Tilak wrote his '*Notes on the interpretation of the Vedāṅga Jyotiṣa: Criticisms and suggestions*' in 1914 while he was lodged in jail in Mandalay, Burma[11] He took for criticism *Y-VJ* 15, 19, 27 (with its variation *R-VJ* 13), 21, 20, 25, 26, 12, 14 and *R-VJ* 19. Of these *Y-VJ* 15, 20, 21, 25 and 26 have been dealt correctly by him, pointing out the defects and mistakes in the interpretations of 'Bārhaspatya' and Sudhakara Dvivedi, but in *Y-VJ* 19 he committed the simple mistake of taking *udvapet* to mean 'should be added', instead of 'should be taken away'. By this he missed the meaning of the verse and, to make up for the error in the rule created thus, he had to misinterpret *Y-VJ* 27 and *R-VJ* 13 as well as to supplement it. Still, his interpretation is only approximate, as he himself has owned. Thus a perfect rule was spoiled by a small mistake. The involved interpretation, requiring several pages of explanation, should itself have told him that he was going on the wrong track. I disagree with his interpretation also of *Y-VJ* 12 and 14 which he takes as providing for the one day to be left out of count, to correct the system to keep in step with reality. *Y-VJ* 27 deals with *lagna*, about the meaning of which he is not sure. In the present edition all these points have been dealt with convincingly.

We have already seen that, at about 1916, Swamikannu Pillai took certain points in the *VJ* for discussion (vide his *Indian Ephemeris*, vol. I, pt. i, pp. 443-56;

'The Vedanga Jyotisha calendar'). In 1936, R. Shamasastry, Retd. Curator, Oriental Library, and Director of the Archaeological Researches in Mysore brought out an edition of the *Y-VJ*, with his own Sanskrit commentary and English translation and notes. It is not a critical edition and in spite of the good interpretations of scholars before him he has misinterpreted almost all the verses included in the Fifth Section of the present edition. He has quoted from the Jain works, but exhibits ignorance not only of their meaning but also of their purpose. For instance, in order to get the *parva-nakṣatras* and *aṃśas*, the number of *nakṣatras* and *aṃśas* moved in one *parva* (which is given as a constant) are multiplied by the number of *parvas*. This cannot be done mentally and, so *Y-VJ* 15 and 18 give simple rules to get it. But Shamasastry interprets that the said two verses give the days not fit for *darśapūrṇamāsa* sacrifices and, even that, using his own peculiar criterion for the same. As for getting the *parva-nakṣatras* and *aṃśas*, he asks us to add to those of the previous *parva*, the motion for one *parva*, and this too in *kalās*, mostly fractional ! His interpretation of *Y-VJ* 13 is a monument for his capacity. And, the most ridiculous aspect is that he criticises the earlier interpreters, who are by far his superiors. Still later, Dr. Satya Prakash offered a detailed treatment of the topics dealt with in the *VJ* in the chapter entitled 'Lagadha: The first to rationalize astronomy' in his book *Founders of Sciences in Ancient India*, (New Delhi, 1965, pp. 455-512), but he takes his translations verbatim from Shamasastry and in the explanations also follows him which makes his treatment liable to the severe limitations of his source-book.

9. *Acknowledgements*

I have the satisfaction now that what I began in 1960 and worked off and on has been duly brought to a completion. I think of all those who have helped me in the publication of this edition, especially to the Bharatiya Vidya Bhavan, Bombay who provided a forum for my expounding the subject in detail in the Workshop on *Ancient insights and modern discoveries* organised by them. My thanks are due to every one who has devoted his attention to the *VJ*, irrespective of whether he has done well or ill, for I have benefited from his work in some way or other. I cherish with gratitude the memory of my two friends who enthused me in the work, first the Vedic and Vedānta scholar, Malma Narashimachariar, a respected preceptor of the Munitrayam Sect, who learnt the *Sūryasiddhānta* and the *Yājuṣa-Vedāṅga Jyotiṣa* from me, and second, Srinivasa Iyengar of Periakulam, Retired Head Master, a Vājasaneyin and a man of many parts with a fund of knowledge who discussed many problems with me and gave me his copy of Tilak's paper on the subject.

T. S. KUPPANNA SASTRY

REFERENCES

[1]Cf. *Ṛgveda* 1.164 48:

द्वादश प्रधयश्चक्रमेकं
त्रीणि नभ्यानि क उ तच्चिकेत ।
तस्मिन्त्साकं त्रिशता न शङ्कवोऽर्पिताः
षष्टिर्न चला चलासः ॥

Cf. also *Ṛgveda* 1.94.4:

भरामेध्मं कृणवामा हवींषि ते
चितयन्तः पर्वणापर्वणा वयम् ।

[2]Cf *Atharvaveda* 19 7.2-5:

सुहवमग्ने कृत्तिका रोहिणी चास्तु भद्रं मृगशिरः शमार्द्रा ।
पुनर्वसू सूनृता चारु पुष्यो भानुराश्लेषा अयनं मघा मे ।
पुण्यं पूर्वा फल्गुन्यौ चात्र हस्तश्चित्रा शिवा स्वाति सुखो मे अस्तु ।
राधे विशाखे सुहवानराधा ज्येष्ठा सुनक्षत्रमरिष्ट मूलम् ॥
अन्नं पूर्वा रासतां मे अषाढा ऊर्जं देव्युत्तरा आ वहन्तु ।
अभिजिन्मे रासतां पुण्यमेव श्रवणः श्रविष्ठाः कुर्वतां सुपुष्टिम् ।
आ मे महच्छतभिषग् वरीय आ मे द्वया प्रोष्ठपदा सुशर्म ।
आ रेवती चाश्वयुजौ भगं म आ मे रयिं भरण्य आवहन्तु ॥

[3]For a detailed exposition, see B. G. Tilak, *Orion*, (Bombay, 1893). See esp. ch. IV. *Agrahāyana*, pp. 61-95.

[4]Cf *Ṛgveda* 5.40.5-6, 9:

यत्त्वा सूर्य स्वर्भानुस्तमसाऽविध्यदासुरः ।
अक्षेत्रविद् यथा मुग्धो भुवनान्यदीधयुः ॥
स्वर्भानोरध यदिन्द्र माया अवो दिवो वर्तमाना अवाहन् ।
गूळ्हं सूर्यं तमसापव्रतेन तुरीयेण ब्रह्मणाऽविन्ददत्रिः ॥
यं वै सूर्यं स्वर्भानुः तमसाऽविध्यद् आसुरः ।
अत्रयस्तमविन्दन् न ह्यन्ये अशक्नुवन् ॥

[5]See *Taitt. Saṃ.* (*Kṛṣna-Yajurveda*), 7.2.6:

ऋतवो वै (सत्रमासत) । त एकादशरात्रमपश्यन् । तमाहरन् । तेनायजन्त ।...एकादशरात्रो
भवति ।...संवत्सरे प्रतिष्ठाप्य... ।

[6]See *Taitt. Saṃ.* 7.1.10:

अनाप्तश्चतूरात्रोऽतिरिक्तः षड्रात्रोऽथवा एष सम्प्रति यज्ञो यत् पञ्चरात्रो य एवं
विद्वान् पञ्चरात्रेण यजते ।

[7]See *Vāj. Saṃ.*, 27.25; *Śatapatha Brāhmaṇa* 8.1.48; *Taitt. Br.* 3.10.4.1; *Taitt. Āraṇyaka* 4 19.1
संवत्सरोऽसि परिवत्सरोऽसि इदावत्सरोऽसि अनुवत्सरोऽसि, इद्वत्सरोऽसि ।

[8]See *Ṛgveda* 1.158.6:

दीर्घतमा मामतेयो जुजुर्वान् दशमे युगे ।

[9]The problem of the Hindu precession has been dealt with elaborately by me (*i*) in the Introduction to my critical edition of the *Māhabhāskarīyam* (Madras, 1957), (*ii*) the Introd. to the *Vākyakaranam* (Madras, 1962) and (*iii*) my paper entitled 'Main characteristics of Hindu Astronomy', *Indian J. Hist. Sc.*, 9 (1974) 31-34.

[10]Alluding to this point Swamikannu Pillai makes the mistake of stating that the Moon would be observed to be "three days old" on the last day of the *yuga*, meaning that the new moon would have gone already.

[11]Included in the posthumous collection of his papers, published under the title, *Vedic chronology and Vedanga Jyotisha*, (Poona City, 1925), pp. 43-104.

PART A

CRITICAL EDITION OF VEDĀṄGA JYOTIṢA

I. ṚGVEDA-VEDĀṄGA-JYOTIṢA

II. YAJURVEDA-VEDĀṄGA-JYOTIṢA

वेदाङ्गज्योतिषम्

I. आर्चज्योतिषम् (R-VJ)

अथ आर्चज्योतिषं प्रारभ्यते ।

पञ्चसंवत्सरमयं युगाध्यक्षं प्रजापतिम् ।
दिनर्त्वयनमासाङ्गं प्रणम्य शिरसा शुचिः ॥१॥

प्रणम्य शिरसा कालमभिवाद्य सरस्वतीम् ।
कालज्ञानं प्रवक्ष्यामि लगधस्य महात्मनः ॥२॥

ज्योतिषामयनं कृत्स्नं प्रवक्ष्याम्यनुपूर्वशः ।
विप्राणां सम्मतं लोके यज्ञकालार्थसिद्धये ॥३॥

निरेकं द्वादशार्धाब्दं द्विगुणं गतसंज्ञिकम् ।
षष्ट्या षष्ट्या युतं द्वाभ्यां पर्वणां राशिरुच्यते ॥४॥

स्वराक्रमेते सोमार्कौ यदा साकं सवासवौ ।
स्यात् तदादि युगं माघस्तपः शुक्लो (ऽयनं ह्युदक्) ॥५॥

प्रपद्येते श्रविष्ठादौ सूर्याचन्द्रमसावुदक् ।
सार्पार्धे दक्षिणार्कस्तु माघश्रावणयोः सदा ॥६॥

घर्मवृद्धिरपां प्रस्थः क्षपाह्रास उदग्गतौ ।
दक्षिणे तौ विपर्यासः षण्मुहूर्त्ययनेन तु ॥७॥

Note: 14 manuscripts, numbered A to N, have been collated to determine the critical text edited here, the unaccepted readings being relegated to the footnotes. The text is corrupt at places. In such cases, if at least one manuscript gives a correct and sensible reading, that is adopted in the 'Edited' text. Where, however, no manuscript gives a satisfactory text, emendations are suggested in brackets (and also explained in the Notes below), all mss. readings being given in the footnotes.

The variant readings are noted under the indication of the relevant verse and *pāda* numbers, *a*, *b*, *c* and *d*. (See page 26).

(द्विगुणं) सप्तमं चाहुरयनाद्यं त्रयोद(शम्) ।
चतुर्थं दशमं (च) द्विर्युग्माद्यं बहुलेऽप्यृतौ ॥८॥

वसुस्त्वष्टा भवोऽजश्च मित्रः सर्पाश्विनौ जलम् ।
धाता कश्चायनाद्याश्चार्थपञ्च(म)भस्त्वृतुः ॥९॥

भांशाः स्युरष्टकाः कार्याः पक्षद्वादशकोद्‌गताः ।
एकादशगुण(श्चो)नः शुक्लेऽर्धं चैन्दवा यदि ॥१०॥

कार्या भांशाष्ट(क)स्थाने कला एकान्नविंशतिः ।
ऊनस्थाने (त्रि)सप्त(तिमु)द्वपेदूनसम्मिताः ॥११॥

(त्र्यंशो) भशेषो दिवसांशभाग-
श्चतुर्दश(श्चाप्यनीय) भिन्नम् ।
भार्धेऽधिके (चापि गते परोंऽशो)
द्वावुत्तमे नवकैरवेद्यम् ॥१२॥

पक्षात् पञ्चदशाच्चोर्ध्वं तद्भुक्तमिति निर्दिशेत् ।
नवभिस्तूद्‌गतोंऽशः स्यादूनांशद्व्यधिकेन तु ॥१३॥

जौ द्रा घः खे श्वे ऽही रो षा
चिन् मू ष ण्यः (सू मा धा णः) ।
रे मृ घाः स्वा ऽपोऽ जः कृ ष्यो
ह ज्ये ष्ठा इत्यृक्षा लिङ्गैः ॥१४॥

जावाद्यंशैः समं विद्यात् पूर्वार्धे पर्वसूत्तरे ।
भादानं स्यात् (चतुर्दश्य) काष्ठानां देविना कलाः (?) ॥१५॥

कला दश (स)विंशा स्यात् (द्वे) मुहूर्तस्य नाडिके ।
(द्यु)त्रिशत् तत्कलानां तु षट्छती त्र्यधिकं भवेत् ॥१६॥

नाडिके द्वे मुहूर्तस्तु पञ्चाशत्पलमा(ढ)कम् ।
(आढ)कात् कुम्भको द्रोणः कुटपैर्वर्धते त्रिभिः ॥१७॥

(ससप्तकं) भयुक् (सोमः) (सूर्यो द्यूनि) त्रयोदश ।
नवमानि च पञ्चाह्नः काष्ठाः पञ्चाक्षराः स्मृताः ॥१८।

श्रविष्ठायां (ग)णाभ्यस्तान् प्राग्विलग्नान् विनिर्दिशेत् ।
(स्त)र्यान् मासान् षळभ्यस्तान् विद्याच्चान्द्रमसान् ऋतून् ॥१९॥

अतीतपर्वभागे(भ्यः) शोधयेद् द्विगुणां तिथिम् ।
तेषु मण्डलभागेषु तिथिनिष्ठांगतो रविः ॥२०॥

याः पर्वभादानकलास्तासु सप्तगुणां तिथिम् ।
प्रक्षिपेत् (तत्)समूहस्तु विद्यादादानिकीः कलाः ॥२१॥

यदुत्तरस्यायनतो गतं स्या-
च्छेषं तु यद् दक्षिणतोऽयनस्य ।
तदे(क)षष्ट्या द्विगुणं विभक्तं
सद्वादशं स्याद् दिवसप्रमाणम् ॥२२॥

(य)दर्धं दिनभागानां सदा पर्वणि पर्वणि ।
ऋतुशेषं तु तद् विद्यात् संख्याय सहपर्वणाम् ॥२३॥

इत्युपायसमुद्देशो भूयोऽ(प्यह्न) प्रकल्पयेत् ।
ज्ञेयरा(शि)गताभ्य(स्तं) विभजेत् ज्ञानराशि(ना) ॥२४॥

अग्निः प्रजापतिः सोमो रुद्रोऽदितिर्बृहस्पतिः ।
सर्पाश्च पितरश्चैव भगश्चैवार्यमापि च ॥२५॥

सविता त्वष्टाथ वायुश्चेन्द्राग्नी मित्र एव च ।
इन्द्रो निर्ऋतिरापो वै विश्वेदेवास्तथैव च ॥२६॥

विष्णुर्वसवो वरुणोऽज एकपात् तथैव च ।
अहिर्बुध्न्यस्तथा पूषा अश्विनौ यम एव च ॥२७॥

नक्षत्रदेवता एता एताभिर्यज्ञकर्मणि ।
यजमानस्य शास्त्रज्ञैर्नाम नक्षत्रजं स्मृतम् ॥२८॥

इत्ये(वं) मासवर्षाणां मुहूर्तोदयपर्वणाम् ।
दिनर्त्वयनमासाङ्गं व्याख्या(नं) लगधोऽब्रवीत् ॥२९॥

सोमसूर्य(स्तृ)चरि(तं) लो(कं) लोके च सम्मतिम् ।
सोमसूर्य(स्तृ)चरि(तं) विद्वान् वेदविदश्नुते ॥३०॥

विषुवं तद्गुणं द्वाभ्यां रूपहीनं तु षड्गुणम् ।
यल्लब्धं तानि पर्वाणि त(थार्धं) सा तिथिर्भवेत् ॥३१॥

माघशुक्लप्रवृत्त(स्य) पौषकृष्णसमापिनः ।
युगस्य पञ्चवर्ष(स्य) कालज्ञानं प्रचक्षते ॥३२॥

तृतीयां नवमीं चैव पौर्णमासी(मथासिते) ।
षष्ठीं च विषुवान् प्रोक्तो द्वाद(शी) च समं भवेत् ॥३३॥

चतुर्दशीमुपवसथस्तथा भवेद् यथोदितो दिनमुपैति चन्द्रमाः ।
माघशुक्लाह्निको युङ्क्ते श्रविष्ठायां च वार्षिकीम् ॥३४॥

यथा शिखा मयूराणां नागानां मणयो यथा ।
तद्वद् वेदाङ्गशास्त्राणां ज्योतिषं मूर्धनि स्थितम् ॥३५॥

वेदा हि यज्ञार्थमभिप्रवृत्ताः
कालानुपूर्वा विहिताश्च यज्ञाः ।
तस्मादिदं कालविधानशास्त्रं
यो ज्योतिषं वेद स वेद यज्ञान् ।।३६।।
यो ज्योतिषं वेद स वेद यज्ञान् ।।

पञ्चसंवत्सरमयम् (श्लो १) । प्रपद्येते (श्लो ६) । कार्याः (श्लो ११) । कला दश च (श्लो १६) । याः पर्व (श्लो २१) । सविता (श्लो २६) । विषुवं (श्लो ३१) । सप्त ।।

।। इति आर्चज्योतिषं समाप्तम् ।।

आर्चज्योतिषम् (R-VJ) : VARIANT READINGS

1. (*b*) I. प्रजा repeated. (*d*) M. लग्नधस्य
4. (*b*) G. त्रिगुणं. (*d*) G. राशिमुच्यते
5. (*a*) A. B. D. F. स्वरर्कं; C. E. स्वरार्वी; G. H. स्वरार्कं; all mss. मेके (G. मेते).
   (*d*) All mss. शुक्लो दिनं त्यजः ।
6. (*c*) G. चान्द्र
7. (*a*) A.C. रप्रो प्रस्थः. (*b*) C.E. उदगातौ. (*c*) J. दक्षिणा; G. ता विप; A.C.E.H.I.J.K.L.M. विपर्यस्तौ.
   (*d*) C.E. मुहूर्त्यं; G. मुहूर्तं; N. मुहूर्ता
8. (*a*) All mss. प्रथमं for द्विगुणं; G. om. सप्तमं. (*c*) All mss. चैव for च. (*d*) N. द्वियुग्मा; G. स्मृतौ.
9. (*b*) M. मित्रा; L. सार्पा. (*d*) All mss. पञ्चनभ
10. (*c*) All mss. गुणस्योनः (G. स्योन).
11. (*a*) All mss. ष्टकास्थाने (*b*) N. एका॰ न. (*c*) All mss. द्वि for त्रि. (*c-d*) All mss. सप्ततीरुद्वपेद्. (*d*) G. सम्मिकाः
12. (*a*) A.B.C.E. त्रियंशी, D. त्रियशो, G H K.M त्र्यहंश, I त्र्यहंशो, J. त्र्यहंशी; C.E. भशेषा, K M.N. भशेषो
   (N.॰भः शेषो), K. सांशभाग. (*b*) All mss. read: दंशस्याप्युपनीतभिन्नम्. (*c*) G. भार्धे च के;
   All mss. चाधिगते परेंऽशे. (*d*) N त्तमेकं; G. ख्रखम्.
13. (*b*) G. तद्भुक्तमिति
14. (*a*) N. द्रा मः भे; G. श्वे हे; (*b*) All mss. सोमाधानः (G. सोमानानः). (*c*) G. ने मु; H.L. श्या for स्वा
   (*d*) G. इत्यलक्षा, N. इत्याक्षा
15. (*b*) All mss. चतुर्दशी; G. पूर्वर्धे; G L. पूर्वं सू, I पार्वं सू; (*c*) H.J. भादानां
16. (*a*) All mss. च for स, all mss. विंश for विंशा. (*b*) All mss. द्वि for द्वे, G.H. मुहूर्तस्तु. (*c*) All mss. द्विंत्रिंशत्;
   G. शकलानां. (*d*) G. षट्चतुर्थ्यधिकं
17. (*b*) All mss. माषकम् (G. मूषकम्). (*c*) All mss. माषकात् (G. मूषकात्); G. कुम्भका, I.K.M. कुम्भयोः,
   (*d*) G. कुटवैः
18. (*a*) All mss. ससप्तकुं; all mss. स्योनः (N.भयुक्तेन्धानः). (*b*) all mss. सूर्याद्योनिं (*c*) G. पचचज्ञाः,
   (*d*) N. काष्ठा
19. (*a*) H.I.J K. शविष्ठा; all mss गुणा (N. भगणा). (*c*) All mss. सूर्यान्. (*d*) A.B.D.F. विद्याचान्द्र, C.E. विद्याशचन्द्र
20. (*a*) All mss. भागेषु (G. भागे तु). (*b*) C E. शोधयेद्विणां; M. चाधयेत्
21. (*c*) प्रक्षिपेत् कलासम् (K. पेतला, N. कल). (*d*) C.D.E.H. दादनकीः

22. (*c*) All mss. तदेव षष्टया; F. द्विभक्तं.
23. (*a*) C.E.F.G-N. तद; C.D दर्घं. (*d*) A.B. संख्यया, C.D E. संखाय
24. (*a*) C.E. इलुपाय (*b*) All mss. भूयोऽप्येनं; C.E प्राकल्प (*c*) All mss राशिं; A.B. गतान् व्यस्तान्, L. गतोऽभ्यस्तान्; all other mss. गताभ्यस्तान् (*d*) C.E भ जेज्ज्ञन, all mss. राशिषु
25. (*b*) N ब्रह्मणस्पतिः. (*c*) G. सार्पाश्चैतपश्चैव
26. (*b*) N. न्द्राग्नि; C.E. मित्री
28. (*a*) A.B.E. ह्योता. (*c*) G.शास्त्रज्ञः
29. (*a*) All mss इत्येतन्मास, G. वर्षाणि. (*b*) G पर्वणि. (*d*) All mss. व्याख्यातं; (G) लगधेऽब्र
30. All mss सूर्यस्त्रि (N सूर्यत्रि); all mss. चरितो (G चरित, K. जरितो). (*b*) All mss लोकात् (A. लोकाल्, D. लोकान्, B.G.K. लोकां, L लोका), H.K. सम्मितम्, N. सम्मिता. (*c*) All mss. सूर्यस्त्रि; all mss चरितो (G. चरित. K. जरितो). (*d*) G. विद्वानेव विदश्नुते.
31. (*a*) C.E. द्वाभ्या रूप. (*b*) (*g*) रूपहानं; C.E. षड्गुणम्. (*c*) C.F. यल्लब्धं. (*d*) All mss. तथोर्ध्वं; N तिथेर्भवेत्.
32. (*a*) G. माघशुद्ध; all mss. प्रवृत्तस्तु. (*b*) N. समापिण, (*c*) C. E. युगस्यु
33. (*b*) All mss. मासी त्रयोदशीम्. (*c*) H. षष्ठी च; A.B. विषवा, C.D.E.F.L. विषुवा. (*d*) All mss. द्वादश्या च (G. द्वादश्यायन); G. संभवेत्; N. समप्रभम्.
34. (*a*) G. मुपवसदस्तदा. (*b*) G. सतोदितो; G.H. मुपेति. (*c*) N. क्लाह्निके; N. युक्ते (*d*) E. शविष्ठा; G. ष्ठावा; N. यां पञ्चवार्षिकम्.
35. (*d*) C. E. स्थितिम्

II. याजुषज्योतिषम् (Y-VJ)

अथ याजुषज्योतिषं प्रारभ्यते ।

पञ्चसंवत्सरमयं युगाध्यक्षं प्रजापतिम् ।
दिनर्त्वयनमासाङ्गं प्रणम्य शिरसा शुचिः ॥१॥

ज्योतिषामयनं पुण्यं प्रवक्ष्याम्यनुपूर्वशः ।
सम्मतं ब्राह्मणेन्द्राणां यज्ञकालार्थसिद्धये ॥२॥

वेदा हि यज्ञार्थमभिप्रवृत्ताः
कालानुपूर्व्या विहिताश्च यज्ञाः ।
तस्मादिदं कालविधानशास्त्रं
यो ज्योतिषं वेद स वेद यज्ञम् ॥३॥

यथा शिखा मयूराणां नागानां मणयो यथा ।
तद्वद् वेदाङ्गशास्त्राणां गणितं मूर्धनि स्थितम् ॥४॥

ये बृहस्पतिना भुक्ता मीनात् प्रभृति राशयः ।
(ते हृता.) पञ्चभि(र्भू)ता यः शेषः स परिग्रहः ॥४-०॥
(un-numbered verse in mss.)

Note: 6 manuscripts, A to F, form the basis of the critical text presented here. For the methodology adopted in recording the variants, see *Note* to *Ārca Jyotiṣam* (R-VJ), (p. 23). For variant readings of *Yājuṣajyotiṣam*, see p. 31.

माघशुक्लप्रपन्नस्य पौषकृष्णसमापिनः ।
युगस्य पञ्चवर्षस्य कालज्ञानं प्रचक्षते ।।५।।

स्वराक्रमेते सोमार्कौ यदा साकं सवासवौ ।
स्यात्तदादि युगं माघस्तपश्शुक्लोऽयनं ह्युदक् ।।६।।

प्रपद्येते श्रविष्ठादौ सूर्याचन्द्रमसावुदक् ।
सार्पार्धे दक्षिणार्कस्तु माघश्रावणयोः सदा ।।७।।

घर्मवृद्धिरपां प्रस्थः क्षपाह्रास उदग्गतौ ।
दक्षिणे तौ विपर्यासः षण्मुहूर्त्ययनेन तु ।।८।।

प्रथमं सप्तमं चाहुरयनाद्यं त्रयोदशम् ।
चतुर्थं दशमं (च द्वि) र्युग्माद्यं बहुलेऽप्यृतौ ।।९।।

वसुस्त्वष्टा भवोऽजश्च मित्रः सर्पोऽश्विनौ जलम् ।
धाता कश्चायनाद्याः स्युरर्धपञ्चमभस्त्वृतुः ।।१०।।

एकान्तरेऽह्नि मासे च पूर्वान् कृत्वादि(मु)त्तरः ।
अर्धयोः पञ्चवर्षाणां (ऋदु) पञ्चदशाष्टमे ।।११।।

(द्यु) र्हेयं पर्व चेत्पादे पादस्त्रिंशत्तु सैकिका ।
भागात्मनापवृज्यां(शान्) निर्दिशेदधिको यदि ।।१२।।

निरेकं द्वादशाभ्यस्तं द्विगुणं (गतसंयुतम्) ।
षष्ट्या षष्ट्या युतं द्वाभ्यां पर्वणां राशिरुच्यते ।।१३।।

स्युः पादोऽर्धं त्रिपाद्या या त्रिद्व्येकेऽह्नः (कृता) स्थितिम् ।
साम्येनेन्दोः (स्त्वृ)णोऽन्ये तु पर्वकाः पञ्चसम्मिताः ।।१४।।

भांशाः स्युरष्टकाः कार्याः (पक्ष)द्वादशकोद्गताः ।
एकादशगुणश्चोनः शुक्लेऽर्धं चैन्दवा यदि ।।१५।।

नवकैरुद्गतोंऽशः स्यादूनः सप्तगुणो भवेत् ।
आवापस्त्वयुजेऽर्धं स्यात् पौलस्त्येऽस्तंगतेऽपरम् ।।१६।।

जावाद्यंशैः समं विद्यात् पूर्वार्धे पर्वसूत्तराः ।
भाऽऽदानं स्याच्चतुर्दश्या (द्यु)भागेभ्योऽधिको यदि ।।१७।।

जौ द्रा गः खे श्वे ऽही रो षा
चिन् मू षण् यः सू मा धा णः ।
रे मृ घाः स्वा ऽपो ऽजः कृ ष्यो
ह ज्ये ष्ठा इत्यृक्षा लिङ्गैः ।।१८।।

कार्या भांशाष्टकस्थाने कला एकान्नविंशतिः ।
ऊनस्थाने (त्रि)सप्ततिमुद्वपे(दूनसम्भवे) ॥१९॥

तिथिमेकादशाभ्यस्तां पर्वभांशसमन्विताम् ।
विभज्य भसमूहेन तिथिनक्षत्रमादिशेत् ॥२०॥

याः पर्वभादानकलास्तासु सप्तगुणां तिथिम् ।
(युक्त्या) तासां विजानीयात् तिथिभादानिकाः कलाः ॥२१॥

अतीतपर्वभागेभ्यः शोधयेद् (द्विगुणां) तिथिम् ।
तेषु मण्डलभागेषु तिथिनिष्ठांगतो रविः ॥२२॥

विषुवन्तं द्विरभ्यस्तं रूपोनं षड्गुणीकृतम् ।
पक्षा यदर्धं पक्षाणां तिथिः स विषुवान् स्मृतः ॥२३॥

पलानि पञ्चाशदपां धृतानि
तदाढकं द्रोणमतः प्रमेयम् ।
त्रिभिर्विहीनं कुडवैस्तु कार्यं
तन्नाडिकायास्तु भवेत् प्रमाणम् ॥२४॥

एकादशभिरभ्यस्य पर्वाणि नवभिस्तिथिम् ।
युगलब्धं सपर्वं स्याद् वर्तमानार्क(भं) क्रमात् ॥२५॥

सूर्यर्क्षभागान् नवभिर्विभज्य
शेषं द्विरभ्यस्य दिनोपभुक्तिः ।
ति(थे)र्युता भुक्तिदिनेषु कालो
(योगो) दिनैकादशकेन तद्भम् ॥२६॥

(त्र्यंशो) भशेषो दिवसांशभाग-
श्चतुर्दशश्चाप्यनीय भिन्नम् ।
भार्धेऽधिके चापि गते परोंऽशो
द्वावुत्तमे तन्नव कै रवे(त्य) ॥२७॥

त्रिशत्यह्नां सषट्षष्टिरब्दः षट् चर्तवोऽयने ।
मासा द्वादश सूर्या(:) स्युः एतत्पञ्चगुणं युगम् ॥२८॥

उदया वासवस्य स्युर्दिनराशिः (स)पञ्चकः ।
ऋषेर्द्विषष्टिहीनं स्याद्विंशत्या (सै)कया स्तृणाम् ॥२९॥

पञ्चत्रिंशं शतं पौष्णमेकोनमयनान्यृषेः ।
पर्वणां स्याच्चतुष्पादी काष्ठानां चैव ताः कलाः ॥३०॥

सावनेन्दु(स्तृ)मासानां षष्टिः (सैक)द्विसप्तिका ।
द्युत्रिंशत् सावनः सार्धः सूर्यः (स्तृ)णां स पर्ययः ॥३१॥

अग्निः प्रजापतिः सोमो रुद्रोऽदितिर्बृहस्पतिः ।
सर्पाश्च पितरश्चैव भगश्चैवार्यमाऽऽपि च ॥३२॥

सविता त्वष्टाऽथ वायुश्चेन्द्राग्नी मित्र एव च ।
इन्द्रो निर्ऋतिरापो वै विश्वेदेवास्तथैव च ॥३३॥

विष्णुर्वसवो वरुणोऽज एकपात् तथैव च ।
अहिर्बुध्न्यस्तथा पूषा अश्विनौ यम एव च ॥३४॥

नक्षत्रदेवता ह्येता एताभिर्यज्ञकर्मणि ।
यजमानस्य शास्त्रज्ञैः नाम नक्षत्रज स्मृतम् ॥३५॥

उग्राण्यार्द्रा च चित्रा च विशाखा श्रवणोऽश्वयुक् ।
क्रूराणि तु मघा (स्वाती) ज्येष्ठा मूलं यमस्य यत् ॥३६॥

(द्यू)नं द्विषष्टिभागेन ह्येयं सौर्यात् सपार्वणम् ।
यत्कृतावुपजायेते मध्येऽन्ते चाधिमासकौ ॥३७॥

कला दश सविंशा स्याद् (द्वे) मुहूर्तस्य नाडिके ।
द्यु(स्त्रिं)शत् तत्कालानां तु षट्छती त्र्यधिका भवेत् ॥३८॥

ससप्तकं भयुक् सोमः सूर्यो द्यूयनि त्रयोदश ।
(नवमानि) तु पञ्चाह्नः काष्ठा पञ्चाक्षरा भवेत् ॥३९॥

यदुत्तरस्यायनतो गतं स्या-
(च्)छेषं तथा दक्षिणतोऽयनस्य ।
तदेकषष्ट्या द्विगुणं विभक्तं
सद्वादशं स्याद्दिवसप्रमाणम् ॥४०॥

यदर्धं दिनभागानां सदा पर्वणि पर्वणि ।
ऋतुशेषं तु तद् विद्यात् (संख्याय) सह पर्वणाम् ॥४१॥

इत्युपायसमुद्देशो भूयोऽप्यह्नः प्रकल्पयेत् ।
ज्ञेयराशिगताभ्य(स्तं) विभजेज् ज्ञानराशिना ॥४२॥

इत्येवं मासवर्षाणां मुहूर्तोदयपर्वणाम् ।
दिनर्त्वयनमासाङ्गं व्याख्यानं लगधोऽब्रवीत् ॥४२-०॥
(un-numbered verse in mss.)

सोमसूर्यस्तृचरितं विद्वान् वेदविदश्नुते ।
सोमसूर्यस्तृचरितं लोकं लोके च सन्ततिम् ।।४३।।
लोक लोके च सन्ततिम् ।।

पञ्चसंवत्सर (श्लो १) । स्वराक्रमेते (श्लो ६) । एकान्तरे (श्लो ११) । नवकैरुद्गतो (श्लो १६) । याः पर्वभादान (श्लो २१) । सूर्यर्क्षभागान् (श्लो २६) । सावनेन्दु (श्लो ३१) । उग्राण्यार्द्रा (श्लो ३६) । यदर्धं (श्लो ४१) । नव ।।

।। इति याजुषज्योतिषम् समाप्तम् ।।

याजुषज्योतिषम् (Y-VJ) : VARIANT READINGS

2 (*c*) ब्राह्मणेन्द्राणां सम्मतं
3. (*b*) F. पूर्वा; F. यज्ञान्
4. (*d*) E. ज्योतिषं for गणित; A मूर्ध्नि सस्थितम्.
4-0. (*c*) All mss त्रिवृता for ते हृता.; all mss. पञ्चभिर्ऋता (E F. पञ्चभिः ऋता)
5. (*c*) E F. पञ्च वर्षाणि
8. (*a*) A विपर्यस्तौ
9. (*b*) A E.F. त्रयोदश (*c*) All mss. चैव द्विर्यु. (*d*) B व्यूतौ, D व्यृतौ
10. (*a*) C. वोयजच्च, D वो यच्च (*b*) B-F सर्पाश्विनौ (*c*) E F. यनाद्या स्यु . (*d*) A. F. पञ्चनभ
11. (*b*) B C. D. पूर्वा कृत्वा, all mss. दिरुत्तर॰, (*c*) A. B C. D. पञ्चपर्वाणा, F. पञ्चपर्वाणा. (*d*) All mss. मृदू (c मृदु); F सप्तदशा, B.C.D.F. ष्टमौ
12. (*a*) All mss. दुहेय (*c* दुहेय); B. पञ्च चेत् (*c*) E. भागान्तराप, B नाप्रवृ; A B.C D. ज्यांशा, E.F ज्यांशा (*d*) B D E F. निर्दिशेंशोधिको
13. (*a*) A निरेके. (*b*) A चाथसं, B C D चयस, E चाय्यस. (*c*) A.F षष्ठया षष्ठया. (*d*) E पर्वाणा
14 (*a*) B.C.D.E पादोर्द्धं; C.D.E F. त्रिपाद्यायाः. (*b*) D. त्रिद्वेके; all mss. कृते स्थितिं (*c*) C. नेन्दो, E. तेन्द्वो, F नेन्दु, all mss स्तृणो, B C D.E णोत्येषु (*d*) A-E पञ्चका. पर्वसम्मिताः
15 (*a*) B-F. भांशा; E F रष्ठका , C कार्या. (*b*) All mss. पक्षा द्वा; F. चोद्गता॰. (*d*) E. शुक्ले मृधे चै, C. चिन्दवा
16. (*a*) A रुद्रतोश॰, B. तोशस्या (*b*) C. दुन.. (*c*) A.E. जे द्वौ स्यात्. (*d*) A. स्त्यगते, C. स्तगते; E.S प्परे
17. (*a*) A.B.C.D जावा. (*b*) A. पूर्वसू; B C.D.F. त्तराम् (*c*) B.C. दानं श्याच्चतु. (*d*) All mss. द्विभागेभ्यो (A. द्विभोवेभ्यो)
18. (*a*) A. जौर्द्रा; F. द्रा व ; B.C.D E खा स्ये, C रोयाव. (*b*) B.C.D.E. चिमू, F. चिष्णू; B.C.D E. सु; A.F सोमा; B.C.D.E.F. धान॰ (*c*) A. रे मूम्वा, B रेमृगा, C. रेमृगाऽ, F. ष्वा श्वायो; all mss कृष्य (*d*) D. हृर्ज्येष्ठा
19. (*a*) C. भाशा (*b*) A.B.C. एका न (*c*) All mss. द्वि सप्तति (*d*) A.E.F पेद् युक्तसम्भवे, B.C.D पेद् व्यक्तसम्भवे C. (पेद् व्युक्त)
20. (*b*) B पञ्चभांश
21. (*b*) F. सप्तगुणा, F. तिथिः (*c*) All mss. उक्तास्तासा
22. (*b*) All mss. ये द्विगुणां. (*d*) B.D. निष्टां
23. (*b*) B.D. रुपोनं. (*d*) B. तिथि; A. स्मृतम्

24. (*a*) A. घृतानि, D. हुतानि
25. (*a*) A. रम्यस्येत्. (*c*) A. सपर्वं. (*d*) All mss भक्रमात्
26. (*a*) D. सूर्यरक्ष; B. भागान्; A. नवर्ति. (*b*) A दिनोविभुक्तिः. (*c*) A F. तिथिर्युक्ता, B. तिथियुक्ता, C.D.E. तिथियुता; E. भुक्तिः, F. भक्त. (*d*) All mss. योग (A योगा); A. दशाह्नेन; A तह्नम्
27. (*a*) A. त्र्यहंशि, B.C D.F, त्रियंशी, F. त्रियंशो; A. भशेषे; A भाग: (*b*) A. दशस्याप्यप. (*c*) B. भाद्विध; C. परोशो (*d*) A.B.D तं नव, C. तंन्नव. (*d*) All mss. रवेद्यम्
28. (*a*) A.B.D E. त्रिशत्यह्नां. (*b*) E. पञ्चर्तवो (*cd*) A स्फु (for स्यु) टेतद्. (*d*) A. युताः, D.F. युतम्
29. (*a*) A. वासवस्यु: (*b*) All mss स्व for स, A. पञ्चकम्, B पञ्चका. (*c*) A. ऋषेद्विषडिन्हीनं. (*d*) All mss. चैकया (A. चैया)
30. (*a*) B.C. पञ्चत्रिंशच्छतं. (*c*) E.F पर्वाणां, A.E. चतु·पादी. (*d*) B D देविकाः कलाः
31. (*a*) A-E. न्दुस्त्रिमासानां, F. न्दुत्. (*b*) A. षष्टिः कैका, B.C.D.F चैका, E. सैका (*c*) A.B.D.E. द्वित्रिंशत्, C. द्वित्रिशत्, A. सावनस्याद्ग:, B D.F. सावनस्यार्धः, C. सावन सार्द्धः, E. सावनस्यार्धं. (*d*) A.D. सूर्यस्त्रीणां, F. सूर्यस्तृणां
32. (*a*) B. प्रजापति
33. (*c*) B.C.D. om. वै
34. (*a*) A.B.D. add in the beg. ब्रह्मा. (*b-c*) A. णोऽहिर्बुध्न्यस्तथैव च। अज एकपात्तथा पूषा (*c-d*) A.E.F. पूषाश्विनौ
35. (*a*) E.F. देवता एता
36. (*b*) B.C.D.E.F. श्रवणा. (*c*) All mss. स्वातिः
37. (*a*) All mss. द्व्यून. (*b*) A. सूर्यात्; B-F पार्वणः, (*c*) A कृतादुप, F कृता उप. (*d*) C. मध्येनये
38. (*a*) B.C.D. सविंश, F. सविंशा. (*b*) A.E.F. स्याद्वि, B. स्याद् द्वि, C.D. स्याद् द्वि , F. मुहूर्तस्तु. (*c*) A. द्युत्रिंशस्, B.F. द्वित्रिंशत्. (*d*) C. षड्गती, E षट्शता; A. त्र्यधिको, B त्र्यधिकं, C. त्यधिक, D. त्यधिकं.
39. A.E.F. ससप्तकु. (*b*) A सूर्याद्यानि. (*c*) All mss. उत्तमानि for नवमानि; A.E च for तु
40. (*a*) F. नतोयन स्या. (*b*) F तु यद् for तथा. (*c*) All mss तदेव, A. दिगुण, F. द्विभक्त.
41. (*a*) B.C.D. यदर्धदिन. (*d*) A. संख्या, B-F. सखाय; B पर्वणि
42. (*a*) A.E.F. राशि, A. गताभ्यस्तान्, B.C.E.F. गतान् व्यस्तान्, D. गतान्यस्ता, (*d*) B-F. जे ज्ञान, B-E. राशिनाम्

42-0. (*a*) C. इत्येय. (*d*) B.C.D व्याख्यातं; All mss. लगतो.

43. (*a*) A. सोमः; all mss. स्विचरितं. (*c*) All mss. स्विचरितं. (*d*) A सम्मित, B.C.D. सन्तत

PART B

RE-ARRANGED TEXT, TRANSLATION AND NOTES

RE-ARRANGED TEXT OF VEDĀṄGA JYOTIṢA

SECTION I

BENEDICTION AND VALEDICTION

1. Introduction

Text 1

pañcasaṃvatsaramayaṃ yugādhyakṣaṃ prajāpatim/
dinartvayanamāsāṅgaṃ praṇamya śirasā śucih//R-VJ 1; *Y-VJ* 1

jyotiṣām ayanam punyam pravaksyāmyanupūrvaśaḥ/
sammatam brāhmanendrāṇāṃ yajñakālārthasiddhaye//R-VJ 3; *Y-VJ* 2

praṇamya śirasā kālam abhivādya sarasvatīm/
kālajñānam pravakṣyāmi Lagadhasya mahātmanaḥ//R-VJ 2

Purifying myself and saluting with bent head Prajāpati, the embodiment and presider over the five-year-*yuga* and who has for his limbs time-segments like the day, month, seasons and courses of the Sun (*ayana*), I shall write systematically about the effect on time of the movement of the luminaries, meritorious by itself and accepted by learned *brāhmaṇas*, for the purpose of determining the proper time for the different sacrifices. (*R-VJ* 1, 3; *Y-VJ* 1-2)

Ārca-Jyotiṣa or *Ṛgveda-Vedāṅga-Jyotiṣa* (*R-VJ*) has a different second verse, which completes the first, thus:

And, having saluted Time with bent head, as also Goddess Sarasvatī, I shall write on the lore of Time, as enunciated by sage Lagadha. (*R-VJ* 2)

2. Importance of Astronomy

Text 2

vedā hi yajñārtham abhipravṛttāh
kālānupūrvyā vihitāś ca yajñāḥ/
tasmād idam kālavidhānaśāstraṃ
yo jyotiṣam veda sa veda yajñān//Y-VJ 3

The vedas have indeed been revealed for the sake of the performance of the sacrifices. But these sacrifices are dependent on the (various segments of) time. Therefore, only he who knows the lore of time, viz. *Jyotiṣa*, understands the performance of the sacrifices (fully). (*Y-VJ* 3)

yathā śikhā mayūrāṇāṃ nāgānām maṇayo yathā|
tadvad vedāṅgaśāstrāṇāṃ jyotiṣam mūrdhani sthitam||R-VJ 35; *Y-VJ* 4

Like the combs of the peacocks and the crest-jewels of the serpents, so does the lore of *Jyotiṣa* stand at the head of all the lores forming the auxiliaries of the Vedas. (*R-VJ* 35; *Y-VJ* 4)

Note 1. Gaṇita, a variant reading for *jyotiṣa* means 'computation' which is the essence of this science.

Note 2. The importance of every kind of lore is stressed by being praised in the manner done here by the writers on that lore.

3. Benediction

Text 3

somasūryastṛcaritaṃ vidvān vedavid aśnute|
somasūryastrcaritaṃ lokaṃ loke ca santatım||R-VJ 30; *Y-VJ* 43

One learned in the Vedas who has also learnt this lore of the movement of the Moon, the Sun and the stars will enjoy, after death, sojourn in the world wherein the Moon, the Sun and the stars have their being, besides having, in this world, an unending line of progeny. (*R-VJ* 30; *Y-VJ* 43)

Note 1 Different deities or groups of deities have their own worlds, where their devotees go and enjoy happiness after death.

4 Valediction

Text 4

ity evam māsavarṣāṇām muhūrtodayaparvanām|
dinartvayanamāsāṅgam(?nām) vyākhyānaṃ Lagadho 'bravīt||
(*Y-VJ*, unnumbered verse after 43)

Thus did the sage Lagadha speak in detail of the (synodic) months, the year, the *muhūrtas*, the risings, the syzygies, the days, the (six) seasons and the courses of the Sun with the (solar) months. (*Y-VJ*, unnumbered verse after 43)

Note 1. In Weber's first and critical edition, this verse appears unnumbered before the last verse 43 of the *Y-VJ*. It is not found in the *R-VJ*. The verse enumerates all items computed in the work, with the name of the source, viz. the work of Lagadha. Perhaps, it is a later addition, to supply this need. Shama Sastry, in his highly uncritical edition of *VJ*, numbers this as 43, and the last verse as 44.

SECTION II

MEASURES OF TIME, ASTERISMS ETC.

1. Time Measures

Text 5

palāni pañcādaśad apām dhṛtāni tad ādhakam dronam ataḥ prameyam/
tribhir vihīnam kudavais tu kāryam tan nādikāyās tu bhavet pramāṇam// *Y-VJ* 24

A vessel which holds (exactly) 50 *palas* of water is the measure called *ādhaka*. From this is derived the *droṇa* measure (which is four times the *ādhaka*). This lessened by three *kudava* measures (i.e. three-sixteenths of an *ādhaka*) is the volume measured (in the clepsydra) for the length of one *nāḍikā* of time. (*Y-VJ* 24)

Note 1. According to the dictum that ultimately some terms will have to be left undefined, and taken from usage, the weight and relation between the weight and volume measures alone are mentioned, just as we say 1 gram of pure water at 4°C is 1 cc. The clepsydra also is not described here. There are several types of this, described in astronomical works.

Note 2. *R-VJ* 17 gives a substitute for this verse:

Text 6

nadike dve muhūrtas tu pañcāśat palamāṣakam (? ādhakam)/
māsa(? āḍha)kāt kumbhako droṇah kuṭapair vardhate tribhiḥ//R-VJ 17

Two *nāḍikās* are one muhūrta. The *āḍhaka* is fifty *palas*. From the *āḍhaka*, *kumbhaka* or *droṇa* increases by three *kuṭapas*. (*R-VJ* 17)

Note 1. Kuṭapa seems to be the same as *kudava* as current in some parts of India. None of the things mentioned are related to one another or the *nāḍikā*. Indeed, fundamentally the lacuna is to be supplied from usage. But here is lacuna with a vengeance.

Text 7

kalā daśa saviṃśā syād dve muhūrtasya nāḍike/
dvi(? dyu)striṃśat tat kalānāṃ tu ṣaṭcchatī tryadhikā bhavet//R-VJ 16; *Y-VJ* 38

The *nāḍikā* (mentioned in the previous verse) is ten *plus* a twentieth *kalās* of time. Two *nāḍikās* make one *muhūrta*. Thirty times the *muhūrta* is a day which is equal to 603 *kalās*. (*R-VJ* 16; *Y-VJ* 38)

Text 8

.. .*pādas triṃśat tu saikikā*/(*Y-VJ* 12b)
.. .*kāṣṭhānām caiva tāḥ kalāḥ*/(*Y-VJ* 30d)

31 *kāṣṭhās* make one *pāda*. (*Y-VS* 12b). (Four *pādas*) (equal to 124) *kāṣṭhās* make one *kalā*. (*Y-VJ* 30d)

Note 1. The word *tāḥ* here refers to the four *pādas* given in the third foot of the verse as *catuspādī*. being a compound of *caturṇām pādānām samāhāraḥ*. The word *pāda* itself means the number 31 by the statement, *pādas triṃśat tu saikikā* (*Y-VJ* 12b). The word *pāda* in this verse also signifies 31.

Note 2. The reason for adopting the above-said significance is that the day is divided into 124 *bhāgas* or parts. Since a quarter (*pāda*) of this is 31, the word *pāda* is used to signify the number 31. Similarly, the asterismal segment also is divided into 124 parts called *aṃśas* or *bhāṃśas*.

Text 9

kāṣṭhā pañcākṣarā bhavet/ *Y-VJ* 39d

One *kāṣṭhā* is equal to five *akṣaras* (letters of double *mātrās*). (*Y-VJ* 39d)

Note 1. The *aksara* mentioned here is the length of time called *gurvakṣara*, equal to two *mātrās* of time.

Text 10

ardhapañcamabhas tvṛtuḥ/(*R-VJ* 9d; *Y-VJ* 10d)

Four and a half asterismal segments is one *ṛtu*. (*R-VJ* 9d; *Y-VJ* 10d)

Note 1. The period of the Sun or Moon moving through 4½ segments is a *ṛtu* related to it, i.e. the Sun's *ṛtu* or the Moon's *ṛtu* But the popular *ṛtu* or seasons is only the Sun's. (Cf. the Vedic statement. *Madhuś ca Mādhavaś ca Vāsantikāv ṛtū*/ *Śukraś ca Śuciś ca Graiṣmāv ṛtū*/*Nabhaś ca Nabhasyaś ca Vārṣikāv ṛtu*/*Iṣaś ca ūrjaś ca Śāradāv ṛtū*/*Sahaś ca Sakasyaś ca Haimantāv ṛtū*/*Tapaś ca Tapasyaś ca Śaiśirāv ṛtū*/(*Vāj. Saṃ.* 13.25; *Tait Sam.* 4.4.11.1).

Text 11

triśatyahnām sasaṣṭir abdaḥ ṣaṭ cartavo 'yane/
māsā dvādaśa sūryāḥ syuḥ etat pañcaguṇam yugam// *Y-VJ* 28

Three hundred and sixty-six days form the solar year. In the year there are six *ṛtus* and two *ayanas* (Sun's courses). In the year there are twelve solar months. Five years make a *yuga*. (*Y-VJ* 28)

Note 1. Thus we have the table:

5 *gurvakṣaras* or 10 *mātrās*	=	1 *kāṣṭhā*
124 *kāṣṭhās*	=	1 *kalā*
10 1/20 *kalās*	=	1 *nāḍikā*
2 *nāḍikās*	=	1 *muhūrta*
30 *muhūrtas*	=	1 day (i.e the civil day)
366 days	=	12 solar months *or* 6 *ṛtus or* 2 *ayanas* or 1 solar year
5 solar years	=	1 *yuga*

Note 2. The *nāḍikā* is thus connected in two ways, first with the speech or musical measure of *mātrā*, and second with the flow of water in the clepsydra of 50 *palas* of pure water, measuring an *āḍhaka*.

Note 3. Yuga means 'joining or coming together', technically the coming together of two or more of the Sun, the Moon, the star-planets, their nodes and the apogees, at the same place in the zodiacal circle marked by the asterisms. The five-year *yuga* mentioned here is the period when the Sun and the Moon meet in the same asterismal position in the zodiac, discovered in the Vedic period itself, and which is roughly correct. The Vedas have a name for each of the years of this *yuga: Saṃvatsaraḥ, Parivatsaraḥ, Idā(ḍā)vatsaraḥ, Anuvatsaraḥ, Id(Ud)vatsaraḥ* (*Vāj. Saṃ.* 27.25), with some variants in certain places.

2. Asterisms: Presiding Deities

Text 12

agniḥ prajāpatiḥ somo rudro 'ditir bṛhaspatiḥ|
sarpāś ca pitaraś caiva bhagaś caivāryamāpi ca||
savitā tvaṣṭātha vāyuś cendrāgnī mitra eva ca|
indro nirṛtir āpo vai viśvedevās tathaiva ca||
viṣṇur vasavo varuṇo 'jaekapāt tathaiva ca|
ahirbudhnyas tathā pūṣā aśvino yama eva ca||
nakṣatradevatā hy etā etābhir yajñakarmaṇi
yajamānasya śāstrajñaiḥ nāma nakṣatrajaṃ smṛtim||
(*R-VJ* 25-28; *Y-VJ* 32-35)

The presiding deities of the asterisms (beginning from *Kṛttikāḥ*) are, respectively: *Agni, Prajāpati, Soma, Rudra, Aditi, Bṛhaspati, Serpents, Pitṛs* (Manes), *Bhaga, Aryaman, Savitā, Tvaṣṭā, Vāyu, Indrāgni, Mitra, Indra, Nirṛti, Waters,*

Viśvedevas, Viṣṇu, Vasus, Varuṇa, Ajaekapād, Ahirbudhnya, Pūṣan, Aśvins and *Yama* The people learned in the religious lores say that these deity-names are to be substituted for their own names in the (*saṅkalpa* of) the *yāga* (of the person on whose behalf the sacrifice is performed, viz.) the *yajamāna*. (*R-VJ* 25-28; *Y-VJ* 32-35)

Note 1. While naming a child, it was the custom in ancient times to choose a name the first letter of which is appropriate to the asterism under which the child was born. A set of letters is associated with the asterisms. Even now, conversely, when a person's *nakṣatra* is not known, he is given a *nakṣatra* appropriate to the first letter of his name, for religious rites or horary predictions In ordinary religious rites, it is declared in the introductory resolution (*saṅkalpa*). 'I, bearing this name and born under this asterism, am going to perform this rite.' But when he happens to be the *yajamāna* in a *yāga*, in the place of his own name and asterism, the deity of the asterism is to be substituted, the idea being that he is now one with the deity and the deity itself is performing the *yāga*, as, say, 'Ajaekapād yajate', meaning, 'Ajaekapād performs this *yāga*.'

Text 13

ugrāṇy ārdrā ca citrā ca viśākhā śravaṇo 'śvayuk/
krūrāṇi tu maghā svātī jyeṣṭhā mūlaṃ yamasya yat//Y-VJ 36

The asterisms *Ārdrā, Citrā, Viśākhā, Śravaṇa* and *Aśvinī* are fierce. *Maghā, Svātī, Jyeṣṭhā, Mūlam* and *Bharaṇī* are cruel asterisms. (*Y-VJ* 36)

Note 1. These are mentioned here as an exception to the previous verse, and the names of the deities of these should not be used for the purpose mentioned. Further, these should be avoided in choosing the time for the performance of auspicious rites like marriage.

Note 2. The *R-VJ* does not have this verse.

3. Rule of Three

Text 14

ity upāyasamuddeśaḥ bhūyo 'py ahnaḥ prakalpayet/
jñeyarāśigatābhyastā (? tam) vibhajet jñānarāśinā//R-VJ 24; *Y-VJ* 42

The following is 'the rule of three' (for obtaining the desired result). This rule of three is to be applied again and again to the day, (using the fundamental and derived constants given in the work, in order to get the various computational rules and results given in the work). The rule is: The known result is to be multiplied by the quantity for which the result is wanted, and divided by the quantity for which the known result is given. (*R-VJ* 24; *Y-VJ* 42)

Note 1. The instruction is concise and looks like an aphorism. There are four items in a proportion, three known and one unknown, which is obtained from the three knowns. Hence the rule to get this is called the 'Rule of three'. The four items are: (*a*) If for so much quantity, (*b*) so much result is got, (*c*) for this much quantity given now, (*d*) how much is the result that will be got? The first two are called *jñāta-rāśis* and the next two are called *jñeya-rāśis*. The application of the rule is: Take the known result, i.e. (*b*), multiply it by the quantity (*c*) for which the result is to be known, and divide by the quantity (*a*) for which the result is given; thus the result to be known, i.e. (*d*), is got. Though the verbal description of the rule is long, it is simple and known to every school boy.

SECTION III

FUNDAMENTAL AND DERIVED YUGA CONSTANTS

1. Yuga and its Elements

Text 15

udayā vāsavasya syuḥ dinarāśiḥ sapañcakaḥ|
ṛṣer dvisaṣṭihīnam syād viṃśatyā saikayā stṛṇām|| *Y-VJ* 29

pañcatriṃśaṃ śataṃ pauṣṇam ekonam ayanāny ṛṣeḥ|
parvaṇāṃ syād catuṣpādo... ||*Y-VJ* 30 a-c

sāvanendus tṛmāsānāṃ ṣaṣṭiḥ saikadvisaptikā|
dyutriṃśat sāvanasyārdhaḥ sūryaḥ stṛṇāṃ sa paryayaḥ|| *Y-VJ* 31

sasaptakam bhayuk somaḥ sūryo dyūni trayodaśa|
navamāni tu pañcāhnaḥ....||*R-VJ* 18a-c; *Y-VJ* 39a-c

Note 1. The present section continues from verse *Y-VJ* 28, given in the previous Section II, Text 11, and its meaning should be understood here, viz. the 366 days form the year and that in the year, there are 6 *ṛtus*, 2 *ayanas* and 12 solar months. Five years make the *yuga*.

The number of risings of the asterism *Śraviṣṭhā* in the *yuga* is the number of days *plus* five (i.e. 1830+5=1835). The number of risings of the Moon is the days *minus* 62 (i.e. 1830−62=1768). The total of each of the Moon's 27 asterisms coming round 67 times in the *yuga* is the number of the days *minus* 21 (i.e. 1830−21=1809). (*Y-VJ* 29)

In the same way, the total of the asterisms of the Sun (which comes round 5 times) is 135. There are one less (i.e. 134) *ayanas* of the Moon (i.e. its northward and southward courses). There are 4 *pādas* (i.e. 4×31=124) *parvas* (or *pakṣas*, or their ends, i.e. bright and dark fortnights) in the *yuga*.... (*Y-VJ* 30 a-c)

There are 60+1, 2, 7 (i.e. 61, 62 and 67) *sāvana* months, lunar (synodic) months, and Moon's sidereal months (cycles), respectively, in the *yuga*. Again, the *sāvana* month contains 30 days. This *plus* half (i.e. $30\frac{1}{2}$) days make the solar month. The number mentioned here (viz. 30) is the number of solar sidereal cycles in the *yuga*. (*Y-VJ* 31)

The Moon comes into contact with each asterism 60+7 (i.e. 67) times during the *yuga*. The Sun stays in each asterism 13 days *plus* 5/9 days. (*R-VJ* 18 a-c; *Y-VJ* 39 a-c).

Note 2. Any three elements of the *yuga*, pertaining to the Sun and Moon, not totally dependent on one another, if given, will enable us to calculate every other thing mentioned here, which latter might be called derived constants with reference to the three fundamentals. For instance, three are in the *yuga*, (*i*) 5 years, (*ii*) 1830 days and (*iii*) 62 synodic lunar months. With a little knowledge of astronomy and knowing the definitions, we can compute the others thus:

(*a*) Sidereal risings (i.e. sidereal days)=solar risings (i.e. ordinary days) *plus* solar cycles (i.e. solar years)=1830+5=1835 (given in the text as risings of *Śraviṣṭhā*).
(*b*) Lunar cycles=Synodic months *plus* solar years=62+5=67 (as given in the text).
(*c*) Moon's risings=Risings of *Śraviṣṭhā* (or any other star) *minus* Moon's cycles=1835−67=1768, as given in the text. The other given numbers can be obtained from these by division or multiplication.

Note 3. Though the Moon's *ayanas* are not commonly spoken of, it must also have northward and southward courses, during each sidereal cycle, since its orbit also, roughly following the ecliptic, must cross the celestial equator northward and southward.

Note 4. Since there are 2 *pakṣas* (*parvas*) in each synodic month, there are 62×2 =124 *pakṣas* in the *yuga*. It is this that has necessitated the division of the day into 124 parts, in order to give whole number results as far as possible.

Note 5. The reading *navamāni* of *R-VJ* 18 has been adopted in the place of *uttamāni* of *Y-VJ* 39, the latter being not suitable to the context.

2. Lagnas in the Yuga

Text 16

Śraviṣṭhābhyo gu(?ga)ṇābhyastāt prāgvilagnān vinirdiśet|
sū(?sta)ryān māsān ṣaḍabhyastān vidyāt cāndramasān ṛtūn||R-VJ 19

Using the risings of *Śraviṣṭhā* in the *yuga* (viz. 1835), which are also the number of its Orient Ecliptic points (*prāg-lagna*), and multiplying it by the number in the group (here, of asterisms, viz. 27), we get the total number of *lagnas* in the *yuga* (viz. 1835×27=49,545). Multiplying the sidereal revolutions of the Moon in the *yuga* by 6, we get the total number of lunar *ṛtus* (viz 67×6=402). [Considering the mandatory verb in the first half of the verse, one can translate it also as: Using the distance of *Śravisṭhā* from the rising point (i.e. its hour angle), and multiplying it by 27, we get the *lagna*, in asterisms and parts)]. (*R-VJ* 19)

Note 1. In the *yuga*, the Sun makes five rounds forwards in the zodiac, which itself is rotating rapidly backwards round the earth. Since the time of the motion of the Sun relative to the earth is the civil day, and there are 1830 civil days in the *yuga*, the zodiac itself rotates round the earth 1835 (1830+5) times in the *yuga*, the time of one rotation being called a sidereal day.

Note 2. A single or a group of asterisms of asterismal segments, being fixed in the zodiac, makes the same number of rotations. *Lagna*, as usually used, is the point of the ecliptic rising on the eastern horizon Sometimes the word *prāg-lagna* is used to distinguish it from the Occident (West) Ecliptic point and Meridian Ecliptic point (*daśama-lagna*). Now-a-days *lagna* is mentioned only in connection with the *rāśis*. In those days there was no division into *rāśis*, but there was the division of the zodiac into *nakṣatra* segments. We do not know whether the *lagna*, in those days, was of the asterisms themselves or the asterismal segments. The exact time of the rising of any point can be calculated from its distance from the diurnal circle, the whole *maṇḍala* representing 603 *kalās* or 124 parts of time. (See also Section V. 4, below.)

Note 3. In the text the syllable *gu* has been emended into *ga*, making *guṇa* into *gaṇa* by me. Dikshit has taken *guna* to mean 3, according to the *bhūtasaṅkhyā* notation, but this notation does not seem to have been in vogue at such an early period. In the whole of the work we do not find it used anywhere else. But Bārhaspatya commits a worse mistake by interpreting *guṇa* as 8 in the *bhūtasaṅkhyā*, which transgresses all conventions. This kind of transgression will result in ambiguity, while the requirement is that the numbers are precise.

Note 4. The Sun or Moon's *ayanas* is spoken of as beginning from their situation at the first point of the Sravisthā segment or midpoint of the Āslesā segment, repsectively (See *Y-VJ* 7 in Section IV. 2, below). The *ayanas* have 3 *ṛtus* each. The sidereal period containing 2 *ayanas* have 6 *ṛtus*. In the *yuga*, having 67 sidereal periods of the Moon, the *ṛtus* are 67×6=402. It is noted that while the names of the *ṛtus* Sisira, Vasanta etc. beginning with the Sun at Śraviṣṭhā are significant as referring to real seasons, in the case of the Moon, they are simply nominal.

Note 5. I have emended *sṛ* into *sta*, making it *staryān* which means 'pertaining to the stars (*stṛ*)', much like the Vedic word *narya*, since the word *starya* is an uncommon

word, it is easily mistaken to be *sūrya* in the copying of manuscripts. But the lunar *ṛtus* cannot be related to the solar months, as it transgresses the statement *ardhapañcamabhas tv ṛtuḥ*, which justifies the emendation. Ṛgvedins pronounce even classical *ḍa* as *ḷa* as in the Veda itself.

3. Day-Time

Text 17

gharmavṛddhir apāṃ prasthaḥ kṣapāhrāsa udaggatau/
dakṣiṇe tau viparyāsaḥ ṣaṇmuhūrtyayanena tu//R-VJ 7; *Y-VJ* 8

During the northward course of the Sun, the increase of day-time per day is the same equivalent of one *prastha* (of water used in the clepsydra) The night decreases at the same rate and vice versa during the southward course. During the whole course (*ayana*) the increase or decrease amounts of 6 *muhūrtas* (=12 *nāḍikās*). (*R-VJ* 7; *Y-VJ* 8)

Note 1. The time when the courses begin and end is given in the next Section. From the given data the duration of the course can be calculated to be 183 days, and the increase per day, which is given as one *prastha*, can be calculated from the data in the previous Section to be 4/61 *nāḍikā*. For the whole course of 183 days, the increase is $183 \times 4/61 = 12$ *nāḍikās* or 6 *muhūrtas*.

Note 2. The rate of increase given here is the average per day. It is very crude. Actually, for the first and sixth months of the course it is approximately a sixth of the total, for the second and fifth it is a third, and for the third and fourth it is half.

Note 3. The total increase is not the same in all latitudes. It is proportionate to tan declination × tan latitude. The latitude corresponding to the total given here is 35°, in the extreme north of India. The *Vāsiṣṭha Siddhānta* of the *Pañcasiddhāntikā* of Varāhamihira gives the same total increase, not to speak of the crude *Paitāmaha Siddhānta*.

SECTION IV

TITHI, NAKṢATRA ETC. OF CERTAIN SPECIAL DAYS

The Five-Year Yuga

Text 18

māghaśuklaprapannasya pauṣakṛṣṇasamāpinaḥ/
yugasya pañcavarṣasya kālajñānaṃ prackaṣate//R-VJ 32; *Y-VJ* 5

Men (like the respected Lagadha) give the details about the times of various items in the five-year *yuga* which begins with the bright fortnight of the month

of Māgha and ends with the dark fortnight of the month of Pauṣa. (*R-VJ* 32; *Y-VJ* 5).

Note 1. This gives the epoch, necessary for calculating any item, using the rule of three given in Section II.3.

Note 2. The plural verb needs the understanding of a plural subject.

2. Commencement of the Yuga

Text 19

svar ākramete somārkau yadā sākaṃ savāsavau|
syāt tadādi yugam māghaḥ tapaḥ śuklo 'yanam hy udak||

prapadyete śraviṣṭhādau sūryācandramasāv udak|
sārpārdhe dakṣiṇārkas tu māghaśrāvaṇayoḥ sadā||
(*R-VJ* 5-6; *Y-VJ* 6-7)

When the Sun and the Moon occupy the same region of the zodiac together with the asterism *Śraviṣṭhā*, at that time begins the *yuga*, and the (synodic) month of Māgha, the (solar seasonal) month called Tapas, the bright fortnight (of the synodic month, here Māgha), and their northward course (*uttaram ayanam*). (*R-VJ* 5; *Y-VJ* 6).

When situated at the beginning of the *Śraviṣṭhā* segment, the Sun and the Moon begin to move north. When they reach the midpoint of the *Aśleṣā* segment, they begin moving south. In the case of the Sun, this happens always in the month of Māgha and Srāvana, respectively. (*R-VJ* 6; *Y-VJ* 7)

Note 1. The *VJ* system has simplified the various periods as the 5 sidereal revolutions of the Sun in the *yuga* of 1830 days, 67 sidereal revolutions of the Moon in the same period, etc. This is done for civil calendrical purposes, which demand such simplification, just as, in modern times, the year is taken by us now to have 365 days, ordinarily, with one day more once in four years, calling it leap year, with its own further exceptions. This serves only as a framework for a religious clalendar. So, the *yuga* cannot begin exactly at the first point of Śraviṣṭhā segment generally, unless corrected. Further, the given cycle-days are mean, while the actual courses depend upon the true Sun and Moon, affected by the equations of the centre. So, only the region marked by the asterism *Śraviṣṭhā* can be specified. The exact points of the segments where the courses begin were determined by simple calculations based on inspection of the sky. For details see Introduction. The words *ādau* and *ardhe* in *Y-VJ* 7 signify that the exact point of the segments are meant, of course, for the civil calendar.

Note 2. Prapadyete here means 'move', not simply 'reach' and *ayanam* means 'movement', primarily. The secondary meaning is 'the period of movement'. Only the Sun's *ayanam* is popularly used.

Note 3. The beginning of the northward movement of the Sun at *Śraviṣṭhā* and the mention of the day-time to be least here (see Sn. III.3, *Y-VJ* 8) shows that this is the time of the winter solstice. From this, the time when the original work of Lagadha was written can be determined. (See Introduction).

Note 4. There is a corrupt reading *dinam tyajaḥ* for *ayanam hyudak.* This is made much of by some. (See Introduction).

3. Nakṣatras at the Beginning of the Ayanas

Text 20

prathamaṃ saptamaṃ cāhur ayanādyaṃ trayodaśam/
caturthaṃ daśamaṃ caiva (?ca dviḥ) yugmādyam bahule 'py ṛtau//(R-VJ 8; Y-VJ 9)

vasus tvaṣṭā bhavo 'jaś ca mitras sarpo 'śvinau jalam/
dhātā kaś cāyanādyās syuḥ (R-VJ 9a-c; Y-VJ 10 a-c)

The first, seventh, and thirteenth *tithis* of the bright fortnight and the fourth and tenth of the dark fortnight are at the beginnings of the first five *ayanas.* These occur twice, (i.e. these five are to be repeated for the next five *ayanas*). *(R-VJ 8; Y-VJ 9)*

The *nakṣatras* at the beginning of the *ayanas* are *Sraviṣṭhā, Citrā, Ārdrā, Pūrvaproṣṭhapadā, Anurādhā, Aśleṣā, Aśvinī, Pūrvāṣāḍhā, Uttaraphalgunī* and *Rohiṇī. (R-VJ 8a-c; Y-VJ 9a-c)*

Note 1. What is actually given is 'the beginnings in the even *tithis,* 4th and 10th, are in the dark fortnight'. In the *ayana* there are 6 synodic months and 6 *tithis* more because the *yuga*=62 synodic months=10 *ayanas,* already given. So, every seventh comes as the beginning. *Ṛtu* means 'a repeating period', here, the fortnight.

Note 2. Since in the *ayana* there are six sidereal revolutions of the Moon and 18×9 more *nakṣatras,* every nineteenth beginning from *Sraviṣṭhā* occurs as an *ayana-nakṣatra. Dhātā* is used as a synonym for Aryaman.

Note 3. I have emended *caiva* into *ca dvih,* omitting the useless word *eva,* which is better than Bārhaspatya's explanation that the last foot with nine syllables is an *ārṣa-prayoga.*

4. The Visuva

Text 21

viṣuvam tadguṇaṃ dvābhyāṃ rūpahīnam tu ṣaḍguṇam/
yallabdham tāni parvāṇi tathordhvam (?tathārdham) sā tithir bhavet//R-VJ 31

viṣuvantam dvir abhyastam rūponam ṣadguṇīkṛtan|
pakṣā yadardham pakṣāṇām tithis sa viṣuvān smṛtaḥ|| Y-VJ 23

tṛtīyām navamīm caiva paurṇamāsīm trayodaśīm (? māsīm athāsite)|
*ṣaṣṭhīm ca viṣuvān proktaḥ dvādaśyām (?daśīm) ca samam bhavet||*R-VJ 33

Double the ordinal number of the *viṣuva* (or equinoctial point) and subtract one. Multiply this by 6. The *parvas* gone are got. Halve this number. The *tithi* at the end of which the *viṣuva* occurs is got. *(R-VJ 31)*

Take the ordinal number of the *viṣuva* and multiply by 2 Subtract one. Multiply by 6. What has been obtained are the number of *parvas* gone. Half of this is the *tithi* at the end of which the *viṣuva* occurs. *(Y-VJ 23)*

The *viṣuva* is declared to occur in the bright fortnight, at the end of the *tithis Tṛtīyā, Navamī,* Full Moon, and in the dark fortnight, at *Ṣaṣṭhī* and *Dvādaśī.* This is repeated once again. *(R-VJ 33)*

Note 1. The *viṣuvas*, being equinoxes, occur at the middle of each of the ten *ayanas*. The interval between the *visuvas* is 124/10 *parvas*=12 *parvas* and 6 *tithis*. So, the time gone at the *n*th *viṣuva*$=(n-\frac{1}{2})$ $(12^{p}\ 6^{t})=(2n-1)$ $(6^{p}\ 3^{t})=(2n-1)\times 6$ *parvas* and half that of *tithis*.

Note 2. There is no verse in either *R-VJ* or *Y-VJ* giving the *nakṣatra* of these points.

Note 3. R-VJ means the same as *Y-VJ 23*. Also *R-VJ* is only an enumeration of the result of *R-VJ 31*.

Note 4. trayodaśa, meaning the 13th *tithi*, in *R-VJ* 33 is wrong, and seems to have found a place here by correspondence to the word *trayodaśam* in *R-VJ* 8. In that verse it is proper since the beginning *tithis* are given for the *ayana* points. But here the ends of the *tithis* are given and there is *dvādaśīm*, which is correct. *dvādaśyām* in the latter half of the verse is to be emended to *dvādaśīm*, to fall in line with the other adverbial accusatives.

5. ṚTUS IN A YUGA

Text 22

ekāntare 'hni māse ca pūrvām kṛtvā" dir(?m) uttaraḥ|
ardhayoḥ pañcavarṣāṇām mṛdu (?ṛdu) pañcadaśāṣṭame|| Y-VJ 11

In each of the two halves of the five-year-*yuga*, in the alternating periods of one synodic month and *tithi*, the next *ṛtu* occurs after the previous one, (in other words, the consecutive *ṛtus* occur at intervals of two synodic months and

two *tithis* because 30 *ṛtus* make up 62 synodic months). Regarding the eighth *ṛtu*, the 15th *tithi* comes as the beginning *tithi*. (*Y-VJ* 11)

Note 1. The first *ṛtu* of the yuga is *Śiśira*, as can be seen from the statement that the first *ṛtu* month is *Tapas* (vide *R-VJ* 7; *Y-VJ* 6), *Tapas* and *Tapasya* being the months of *Śiśira* (cf. *Tapaś ca Tapasyaś ca Śaiśirāv ṛtū*, *Vāj. Saṃ*. 13.25; *Taitt. Saṃ*. 4.4.11.1). The next *ṛtu Vasanta* begins two synodic months and two *tithis* later, i.e. on *Caitra-Śukla Tṛtīyā*, *Śiśira* having begun in the *Māgha-Śukla Prathamā*. This continues for the rest.

Note 2. The 15th *tithi* mentioned as the beginning of the 8th *ṛtu* is *Pūrṇimā*. I have emended *mṛdu* as *ṛdu* and have taken it to mean a contraction for *ṛtu-dyu*.

6. Part of the Day at which Parva ends

Text 23

du (?dyu) heyaṃ parva cet pāde ...
bhāgātmanā 'pavṛjyāṃśān nirdiśed adhiko yadi// *Y-VJ* 12 *a,c-d*

If the end of the syzygy occurs within the first *pāda* (i e. 31 parts of the day), that *tithi* is to be omitted from the reckoning. If the parts are more than 31, the *parva* whose *tithi* is to be omitted is to be found by subtracting the number of parts that has to be lessened for the elapsing of one *parva* each. (*Y-VJ* 12 *a, c-d*)

Note 1. 31 parts is a quarter of the day which is divided into 124 parts. So, less than 31 parts means 'before mid-day'.

Note 2. Even today, the syzygy falling before or after mid-day is crucial in deciding the day for the performance of *iṣṭi*, though the *tithi* is taken now as true *tithi*.

Note 3. The parts of the day, at which the end of each successive *parva* occurs, is 30 parts less and less each *parva*, since the duration of each *parva*=days in the *yuga* divided by 124=15 days *minus* 30 parts. This means 2 parts less for each *tithi*.

Note 4. The verse, however, takes for granted that the parts of the day at which the *parva* ends is known, for then alone can we know in which *pāda* of the day the *parva*-end falls. This can be learnt only by implication from the second half of this verse, since nowhere else in the work has it been given. We can proceed taking the successive 15-day periods in the *yuga*, subtracting 30 parts for each, to get the end of the successive *parvas*. This is given in the verse. But this is the same as taking the *parva* number and subtracting 31 parts, or one *pāda*, for each *parva*. Since we want only the parts, and can neglect whole days accumulated, and, since 4 *pādas* make a full

day, we can cast our fours, take the remainder and subtract one, two or three *pādas* for the remainders 1, 2 or 3. Or, which is the same, we can add 3 *pādas* or 94 parts, add 2 *pādas* or 62 parts, or add one *pāda* or 31 parts to the number of the *parvas* for the remainders 1, 2, 3 respectively, interpreting *bhāgātmanā* to mean *pāda-bhāgātmanā*. Thus we get the simple rule implied by the second half of the verse: Take the ordinal number of the *parva*. Cast out fours and get the remainder. If 1 remains, add 93; if 2 remains, add 62; and if 3 remains, add 31. If there is no remainder, take the number alone. We get the parts at which the *parva* ends.

Example. Find the parts of the day ending: (*i*) 37, (*ii*) 43, (*iii*) 54 *and* (*iv*) 68 *parvas*.

(*i*) Casting out fours from 37, 1 remains. So, $93+37 \div 124=130/124=6$ (module 124). So, 6 is the number of parts of the day at which the 37th *parva* ends. *Verification:* $37 \times 1830 \div 124=546\ 6/124$ days and the 37th *parva* ends.

(*ii*) Casting out fours from 43, remainder is 3. So, $43+31=74$ is the number of parts ending 43 *parvas*. *Verification:* $43 \times 1830 \div 124=634\ 74/124$, which gives 74 parts, neglecting full days.

(*iii*) Casting out fours from 54, 2 remains. So, $62+54=116$ parts at the end of 54 *parvas*. *Verification:* $54 \times 1830 \div 124=796\ 116/124$ days, which gives 116 parts, neglecting full days.

(*iv*) Casting out fours from 68, zero remains. So, 68 itself is the number of parts of the day at the end of the 68th *parva*. *Verification:* $68 \times 1830 \div 124=1003\ 68/124$, which gives 68 parts at the end of 68 *parvas*, neglecting full days.

Note 5. For the sake of convenience, the civil calendar requires the reckoning of days from 1 to 15, consecutively, taking the synodic month to contain 29 or 30 full days. By taking or omitting the day for *iṣṭi* according to this rule, the *iṣṭi* day can be made to be always on the first day of the fortnight, and the jump at any day of the fortnight owing to *tithi-kṣaya* or *avama* can be avoided. The subsequent fortnight when this *tithi-kṣaya* will fall, can also be determined.

Note 6. The *Ṛgvedic* recension does not have this verse, but the number of parts at parva-ending is required for *R-VJ* 20 and 13.

Note 7. Tilak correctly notes that if the civil calendar is to keep sufficiently near the religious calendar, a day has to be omitted for each *yuga*, without being counted in it. He thinks that this verse actually gives this by the words *dyu heyam*. But, where is the day to omit? Like the intercalary month, the day must be mentioned first as an extra day of the *yuga*, and then it should be said that it be omitted for reckoning the *nakṣatra*, *tithi* etc. and their characteristics. Otherwise *dyu heyam* cannot mean what he says. For his explanation that the 93rd *parva* day was so omitted, he says

that the Moon's *nakṣatra* parts at the *parva* is 31. This is wrong. On the other hand, it is 93. Hence the meaning of the verse must be quite different. (See my interpretation here and the explanation in note 5 above.) Mistakes have also been made by 'Bārhaspatya' and Sudhakara Dvivedi in their interpretations.

7. Current Year of the Yuga

Text 24

ye bṛhaspatinā bhuktāḥ mīnāt prabhṛti rāśayaḥ|
trivṛtāḥ (?te hṛtāḥ) pañcabhir ṛ (? bhū) tā yaś śeṣas sa parigrahaḥ
(*Y-VJ, un-numbered verse after* 4)

Count the *rāśi* (30° sign division of the zodiac) in which Jupiter is situated from the *rāśi* called *Mīna* (Pisces). Divide the number by five and take the remainder. This is to be taken as the number of the year current in the five-year *yuga*. (*Y-VJ*, un-numbered verse after 4).

Note 1. The five years are named, respectively, as stated earlier, *Saṃvatsara, Parivatsara, Iḍāvatsara, Anuvatsara* and *Id* (*Ud*)*vatsara*. As any day of the *Vedāṅga* calendar is specified as this day, of this fortnight, of this month, of this year, the ordinal number of the year is also required to specify the day. *R-VJ* 4; *Y-VJ* 13 under Sn. V. 1, below, will illustrate its use.

Note 2. This verse is patently an interpolation. Firstly it is un-numbered and found only in the *Yājuṣa* recension. Secondly, the word *rāśi* itself, meaning the division of the zodiac of 30° each, named *Meṣa* (Aries), *Ṛṣabha* (Taurus) to *Mīna* (Pisces), is of foreign origin and came into India only during the first centuries A.D. along with Greek astrology. Up to and including the time of the early astronomical *saṃhitās* of the last centuries B.C., the only zodiacal divisions known in India were the *nakṣatra* divisions. *Rāśi* as used in the *VJ* means only 'group', for example '*parva-rāśi*', meaning the 'group of fortnights' and '*bha-rāśi*', meaning the 'group of *nakṣatra* segments'.

Note 3. This verse serves a useful purpose and that is why it has been interpolated. The calendric system of the *VJ* is purposely made approximate, in order to serve as a good civil calendar and serve simply as a framework for the religious calendar. In course of time, the error from the correct synodic cycle or solar sidereal year will accumulate and the calendar, on account of wandering further and further away from the truth, will not serve as a framework for the religious calendar. This happens so rapidly that even within a few *yugas* it would become useless, if it is not linked to actual observation by periodic corrections, in the same way as the purely lunar calendar of the Muslims is corrected by the observation of the first appearance of the crescent Moon. But unless connected with the solar year, the Muslim months will recur earlier and earlier so that there is an excess of three years in a century. The Hindu lunar calendar

is linked with the solar year by intercalary months (*adhimāsas*) so that it does wander away. Now, the omission of an *adhimāsa* at intervals indicated by observation in the sky, will link the erroneous civil *VJ* calendar with the actual calendar. But, in course of time, less dependance on observation and more on calculation came into practice. Here it is linked with the correct Jovian year. As discussed in the Introduction, Varāhamihira, linked the rough *Paitāmaha Siddhānta* of the *Pañcasiddhāntikā* with the *Saka* year.

SECTION V

DAILY TITHI, NAKṢATRA ETC.

1. Introductory

In Section IV calendric details like *tithi* and *nakṣatra* of certain specific days, for example, the beginning of the *ayana*, were given as already calculated, because they are small in number. Even for the *ṛtus*, which are thirty in number, these details were given by a rule for calculation, though very simple. But there are 124 *parvas* and 1860 *tithis*. Details like their ending moments cannot be given readymade, because they are so numerous. This calculation has to be done in each case and involves large numbers. To accomplish this mentally, ingenious rules are given in this Section. Scholars who tried to interpret the *VJ* did not even guess that this is what is done here, and so failed, some to a greater degree and some to a smaller degree, baffled by the obscurity of the terms used, for, as the saying goes, *vākyārthajñāne tātparyajñānam api kāraṇam*

2. Computation of Parva-rāśi

Text 25

nirekam dvādaśābhyastaṃ dviguṇam gatasaṃyutam|
ṣaṣṭyā ṣaṣṭyā yutam dvābhyām parvaṇām rāśir ucyate||R-VJ 4; *Y-VJ* 13

Take the ordinal number of the year in the *yuga*. Lessen this by 1, multiply by 12, again multiply by 2, add the *parvas* gone in the year, for every 60 of the total *parvas* add 2, and the number obtained is the *parva-rāśi* (i.e. the total number of *parvas* gone at the time for which calculations are to be made) (By repeating the word, we can also interpret it as Multiply the years gone by 12, add the months gone, double what is obtained, add the *parvas* gone, if any, etc) (*R-VJ* 4; *Y-VJ* 13)

Example: Find the parva-rāśi before the point of time indicated by Anuvatsara, Kārttika Bahula Navamī,

Anuvatsara is the fourth year of the *yuga*. So, 3 years, 9 months and one *parva* (*śukla*) are gone. From this:

Parva-rāśi=(3×12+9) 2+1+2 (for 60 *parvas* gone)=93

Note 1. In each year there are 12 synodic months, each month having 2 *parvas*. After 30 months, an extra (*adhika*) or intercalary month is added to complete the half *yuga*. This is why the two *parvas* are added. Thus, we get the total, there being 62 synodic months or 124 *parvas* in the *yuga*.

3. Asterismal parts

Text 26

syuḥ pādo 'rdham tripādyā yā tridvyeke 'hnaḥ kṛte(?tā) sthitim/
sāmyenendoḥ stṛ(?stvṛ)ṇo 'nye tu parvakāḥ pañcasammitāḥ// Y-VJ 14

On account of the civil days of the *yuga* being divided into quarters, halves and three quarters corresponding to the divisibility of the Moon's asterisms in the *yuga*, the Moon's asterismal parts also are a quarter (i.e. 31 parts), two quarters (i.e. 62 parts), three quarters (i.e. 93 parts) and without residue. But the other parts of the asterisms have to be measured in units of fifth divisions of the parts. (*Y-VJ* 14)

Note 1. This is what is said in this verse: The number of civil days in the *yuga*, containing 124 *parvas*, being 1830, at a quarter (i.e. 31) of the *parvas* the days gone are 457 and 62 parts. The Moon's asterisms gone are 1809÷4=452 and 31 parts. At half (i.e. 62) of the *parvas*, the days gone are 915 and the asterisms gone are 904 and 62 parts. At three quarters (i.e. 93) of the *parvas*, the days gone are 1372 and 62 parts and the asterisms gone are 1356 and 93 parts. In these cases, where the day-parts are full quarters, the asterismal parts are also full quarters. But at all other *parvas*, the day-parts being naturally full, (since the division of the day into 124 parts are expressed for this purpose), the asterismal parts cannot be full. So another division of the day called *kalās*, into 603 parts, is required to express the times of the beginnings of the asterisms. In this unit, the asterism takes exactly 610 to pass. It is five times the number of parts taken by the *tithi* to pass and we have 122×5=610.

This simple statement of fact has made the verse difficult to understand, because it is worded in obscure terms. The difficulty in understanding has naturally led to corruptions in the readings, adding to the difficulty. It is also to be noted that mandates giving the purpose are comparatively easier to understand than statements, because knowing the purpose it is easy to guess the method given to achieve the purpose from the given data.

Note 2. On account of the difficulty, 'Bārhaspatya' makes all sorts of emendations. He arbitrarily divides the *pratipad* into 8 parts, not known to the *yājñikas*, adding some to the new moon *tithi* and some to the *pratipad*, for which he has been criticized by Tilak. Sudhakara Dvivedi has done worse, in his usual manner, making drastic emendations. Tilak himself relates the verse to the intercalary day mooted by him. (cf. Introduction.)

4. Bhāṃśas or Nakṣatra-parts

Text 27

bhāṃśāḥ syur aṣṭakāh kāryāḥ pakṣadvādaśakodgatāḥ|
*ekādaśaguṇaś conaḥ śukle 'rdham caindavā yadi||*R-VJ 10; Y-VJ 15

Eight *nakṣatra*-parts (*bhāṃśas*) are to be put down for every unit in the quotient of the number of *parvas* divided by 12. The remainder is to be multiplied by 11 and added. If the *parva* in question is full moon, 62 parts more are to be added if the parts refer to the Moon's *nakṣatra* (and not the Sun's). (*R-VJ* 10; *Y-VJ* 15)

Note 1. The *nakṣatra*-parts mentioned here are 124th parts. The parts are intended to be used in verses *R-VJ* 14-15; *Y-VJ* 17-18, to find the *nakṣatra* of which these are the parts. This is the point of the *nakṣatra* of the Sun and Moon at the end of the new moon, and of the Sun at the full moon *parva*, without the 62 added, and of the Moon with the 62 added.

Example. Find the nakṣatra-part of the Sun and the Moon at the end of the 93rd parva.

Working as per instructions in the verse:

$93 \div 12 = 7$ quotient, 9 remainder

$7 \times 8 + 9 \times 11 = 155 = 31$, casting out 124.

This gives the Sun's *nakṣatra*-part. Since the *parva* ends a bright fortnight, that is, it is a full moon, the Moon's *naksatra*-parts are got by adding 62, i.e. they are 93.

At the end of the previous, i.e. 92nd *parva*, which is new moon, the *nakṣatra*-parts of both the Sun and the Moon are: $7 \times 8 + 8 \times 11 = 144 = 20$, casting out 124.

Note 2. The proof of the rule is as follows: In the *yuga*, containing 124 *parvas*, the Sun traverses $5 \times 27 = 135$ *nakṣatra* segments. During each *parva*, it traverses $135 \div 124 = 1 + 11/124$ *nakṣatra* segments. Taking the parts alone, this is 11 of the 124th parts. At the end of 12 *parvas*, it is $12 \times (1 + 11/124) = 13 + 8/124$. Taking the parts alone, this gives 8. So, for every 12 *parvas*, it accumulates by 8. For the remainder, the parts

are 11 for each, and so the remainder is multiplied by 11 and added. At new moon, the Moon is with the Sun and the parts are the same. But at full moon, the Moon is opposite the Sun, that is, 13½ segments or 13 *nakṣatras* and 62 parts away. So we add 62 parts for the Moon.

Note 3. ardham here means 'half (of 124 parts)', i.e. 62 parts, that being the number of parts in half day. Again, *pāda* being 31 parts or the first quarter of the day, *ardham* can mean the first half of the day also.

Note 4. 'Bārhaspatya' has not understood the second half of the verse. He writes: "Should the twelve half-months be co-terminous with a complete lunar month, the Moon is half *nakṣatra* and 11 *aṃśas* behind the full moon, syzygy". How can the group of 12 half-months or 6 complete lunar months be at full moon, syzygy? He has missed the meaning of the word *ūnaḥ* and thereby the meaning and purpose of the whole verse. Sudhakara Dvivedi has, as usual, done drastic emendations, and missed the meaning of part of the verse. Tilak well understands the meaning and purpose of the verse.

5. Hour angle and Lagna

Text 28

navakair udgato 'ṃśaḥ syād ūnaḥ saptaguṇo bhavet/
āvāpas tv ayuje 'rdhaṃ syāt paulastye 'stam gate 'param// Y-VJ 16

pakṣāt pañcadaśāc cordhvam tad bhuktam iti nirdiśet/
navabhis tūdgato 'ṃśas syād ūnāṃśadvyadhikena tu// R-VJ 13

Dividing the number of *parvas* by 9, take one part for each quotient. Each of the remainder should be multiplied by 7 and added. If the quotient is odd, add half, (that is 62 parts). If the Moon is setting when the Sun rises (i.e. if full moon *parva*), add another half (i.e. 62 parts). (*Y-VJ* 16).

Note 1. Paulastya (or *Paurastya*) is an old name for the Moon. The sum of the hour angle-parts of the Sun and those of *Śraviṣṭhā* at the end of the *parva* is given here. Since the hour angle of the Sun is already known, we can know the hour angle of *Śraviṣṭhā* by subtracting the Sun's parts from this. As the hour angle-parts of *Śraviṣṭhā* gives the rising point of the zodiac, the asterism's rising point can be got by multiplying it by 27 and dividing by 124 This is the *Lagna* (Orient ecliptic point) in terms of the *nakṣatra* and its parts and envisaged in *R-VJ* 19 in Sn. III. 2 above. There the number of stellar *lagnas* was only apparently given. Here we get the method to find it.

Example. What is the hour angle of Śraviṣṭhā and the lagna at the end of the 93rd parva ?

The Sun's hour angle, already found, is 62, the parts of the day gone being the hour angle (cf. *Y-VJ* 14, Note 1 in Sn. V. 3 above). The sum to be got by this verse is found thus:

On dividing 93 by 9, the quotient is 10 and the remainder 3.
$1\times10+3\times7+62$ (for full moon)$=93$. This is the sum.
Subtracting the Sun's hour angle, $93-62=31$, is the hour angle of *Śraviṣṭhā*.
$31\times27=124=6\frac{3}{4}$ asterisms counted from *Śraviṣṭhā*, i.e. 93 parts of *Bharaṇī*, is the rising point, *lagna*.

After the 15th *tithi* of any *parva*, (i.e. at the end of any *parva*), the total of the *bhaśeṣa* (mentioned in the previous verse, *R-VJ* 12) is to be got in the following manner: For every quotient of division of the number of *parvas* by 9, one diurnal part is to be taken. For each remainder, two parts less than 9 (i.e. 7) parts are to be taken. (*R-VJ* 13)

Note 2. It may be seen that *R-VJ* 13 is parallel to *Y-VJ* 16 and that its meaning is the same as that of the first half of the latter.

Note 3. Since after every 3 *tithis*, the diurnal parts are 6 less, and the part of the rise of *Śraviṣṭhā* itself is one part more, the hour angle of *Śraviṣṭhā* after the end of every 3 *tithis* is 5 parts less, and so at the end of a *parva* it is 25 diurnal parts less. From this, the diurnal parts of *Śraviṣṭhā* can be got directly for the end of *parvas* and added. For ease of computation, we can make it 1 part less for every 5 *parvas*, since $5\times(-25)=-125=1$ (mod. 124).

Note 4. Without using this verse, the hour angle of *Śraviṣṭhā* can be got by adding the zodiacal position of the Sun and the diurnal part (hour angle of the Sun) at *parva*. In this verse, the result of adding the diurnal parts to the hour angle of *Śraviṣṭhā* is given. So, if n is the number of the *parvas*, the result got in the verse$=5n+2$ diurnal parts.

$n/124\times5\times124=5n$, being the zodiacal position of the Sun
$5n+2\times94n=5n+64n$ (mod. 124)
$=5n+2n+62n=7n$ (if n is even) or $7n+62n$ (if n is odd, i.e. full moon, when the Moon is opposite the Sun).
Now, $7n=n\times63/9=63\ (q+r/9)$, where q is the quotient and r the remainder of $n/9$.
$=63q+7r=(62+1)\ q+7r=62q+q+7r$
$=q+7r$ (if q is even) and $62+q+7r$ (if q is odd)

Thus we have the total result given by the verse, $q+7r$, ($+62$ if q is odd, 62 more if n is odd or full moon).

Note 5. 'Bārhaspatya' has not translated the third quarter of *Y-VJ* 16, not understanding what it means. This has landed him in difficulties and he gets out by assuming that the hour angles are not counted from the eastern horizon, as is natural, but are counted separately for each part of the diurnal circle, viz. the eastern horizon, the meridian, the western horizon and the nadir meridian. Tilak has condemned this as baseless.

6. Nakṣatra at any Parva

Text 29

jāvādyaṃśaiḥ samam vidyāt pūrvārdhe parvasūttarāḥ/
bhādānam syāc caturdaśyāṃ dvi(?dyu)bhāgebhyo 'dhiko yadi//
R-VJ 15; *Y-VJ* 17

jau drā gaḥ khe śve 'hī ro ṣā
cin mū ṣaṇ yah sū mā dhā ṇaḥ/
re mṛ ghā svā 'po 'jaḥ kṛ ṣyo
ha jye ṣṭhā ityṛkṣā liṅgaiḥ// *R-VJ* 14; *Y-VJ* 18

Take the *nakṣatras* represented symbolically by *jau* etc. in the given series, in the order one, two, three etc. of the parts of the *naksatras* (found in verse *R-VJ* 10, *Y-VJ* 15; Sn. V. 4), each to each. So many parts of that *nakṣatra* has gone at the end of that *parva* for which that *bhāṃśa* has been found. If the *parva* falls within the first half of the *parva-nakṣatra*, (i.e. if the *naksatra*-part is 62 or less at *parva*), the beginning of the *nakṣatra* to be found (*bhādānam*) will fall in the *parva-tithi*, i.e., the 15th *tithi* itself. If the *nakṣatra*-parts is greater than the parts of the day at which the *parva* falls, the beginning of the *nakṣatra* falls in the *Caturdaśī tithi* day. (*R-VJ* 15, 14; *Y-VJ* 17, 18)

Nakṣatra Table with Symbols

No.	*Symbol*	*Nakṣatra*	*No.*	*Symbol*	*Nakṣatra*
1	Jau	Āsvayujau	14	Mā	Aryamā (Uttaraphālgunī)
2	Drā	Ārdrā	15	Dhāḥ	Anurādhāḥ
3	Gah	Bhagah (Pūrvaphālgunī)	16	Naḥ	Śravaṇaḥ
4	Khe	Viśākhe	17	Re	Revatī
5	Śve	Viśvedevāh (Uttarāṣāḍhā)	18	Mr	Mrgasirsam
			19	Ghāh	Maghāh
6	Hiḥ	Ahirbudhnyaḥ (Uttara Proṣṭhapadā)	20	Svā	Svātī
			21	Pah	Āpaḥ (Pūrvāṣādhā)
7	Ro	Rohiṇī	22	Jaḥ	Ajaejapāt (Pūrvaproṣṭhapadā)
8	Ṣā	Āśleṣā			
9	Cit	Citrā	23	Kr	Krttikāh
10	Mū	Mūlā	24	Ṣyaḥ	Puṣyah
11	Ṣa	Śatabhiṣak	25	Ha	Hastah
12	Nyaḥ	Bharaṇyaḥ	26	Jye	Jyeṣṭhā
13	Sū	Punarvasu	27	Ṣṭhāḥ	Śraviṣṭhāḥ

Note 1. In the *Jāvādi* arrangement of *nakṣatras* enumerated here, they have been arranged from *Aśvinī*, each being the sixth from the previous and represented by means of indicatory symbols formed by syllables taken from their names or their deities.

Example. At the end of the 93rd parva, what is the nakṣatra of the Sun and of the Moon, and also show how many parts of each have gone by.

From the previous example, the Sun's parts at the end of 93 *parvas* are 31 and the Moon's 93. So the Sun's *nakṣatra* is 31 (mod. 27), i.e. the 4th *nakṣatra* in the *Jāvādi* series, viz. *Viśākhā* at parts 31. The Moon's *nakṣatra* is 93 (mod. 27)=12 giving *Bharaṇī* at parts 93. Note that the Sun and Moon are $13\frac{1}{2}$ *nakṣatras* from each other.

The answers can be verified directly thus: For the 124 *parvas* of the *yuga*, the Sun traverses 135 *nakṣatra* segments. For 93 *parvas* it traverses $93 \times 135 \div 124 = 101$ and 31/124 which (mod. 27) is 20 and 31/124, i.e. 31 parts in the twentyfirst *nakṣatra*, i.e. *Viśākhā*, reckoned from the first, viz. *Śraviṣṭhā*.

Note 2. The *R-VJ* recension has the reading *uttare* in the place of *uttarāḥ*, which gives better grammatical agreement. The last quarter of this recension, the corrupt *kāṣṭhānām devinā kalāṇ*, has strayed here from elsewhere. The words *dyubhāgebhyo 'dhiko yadi* is essential to complete the expression *bhādānam syāc caturdaśyām*.

Example. The number of the Moon's nakṣatra-parts is 93 at the end of the 93rd parva, falling at 62 parts of the day. Does the beginning of the nakṣatra fall in the 15th or 14th tithi?

The Moon's *nakṣatra*-parts being greater than 62, the beginning of the *nakṣatra* falls in the *Caturdaśī tithi*. This is got by contrast from the given rule. Positively, the Moon's *nakṣatra*-parts, 93 being greater than the day-parts, 62, the beginning falls in the *Caturdaśī* day, that is, the previous day.

Explanation. Since the *nakṣatra* takes 7 *kalās* longer than the day to pass, the *nakṣatra*-part takes longer than a day-part to pass. So, if the *nakṣatra* at *parva* is greater than the day-parts, more time than the day-parts would have been taken by the *nakṣatra*-parts to pass. Therefore, the *nakṣatra* must have begun earlier than the civil day. How much earlier is given by the verse *R-VJ* 11; *Y-VJ* 19, below. (Sn. V. 7)

As for the first rule, referring to the *tithi* proper, half the *nakṣatra*-parts, i.e. 62, takes certainly less time than one *tithi*, which takes 122 parts to pass. So the *nakṣatra* must have begun right within the *parva-tithi*, that is, the 15th *tithi* itself, either on that civil day itself, or on the previous civil day.

Note 3. From the explanation given above, it will be seen that the two rules are not redundant: one refers to the *tithi* proper and the other to the civil day marked by the *tithi*. For example, if at *parva* end the *nakṣatra*-parts are 44 and the day-parts are 4, the beginning falls in the 15th *tithi* itself but on the previous day. If the *nakṣatra*-parts are 22 and day-parts 64, the beginning falls in the 15th *tithi* on the same civil day.

7. Kalās for Moon's Nakṣatra

Text 30

kāryā bhāṃśāṣṭakasthāne kalā ekānnaviṃśatih|
ūnasthāne dvi(?tri)saptatim udvaped ūnasambhave||R-VJ 11; *Y-VJ* 19

R-VJ has a better reading for the last quarter: *saptatīr udvaped ūnasammitāḥ.*

> For every 8 *nakṣatra*-parts, 19 *kalās* are to be set down for work. For the less (i.e. the remainder), when the remainder occurs, take away 73 *kalās* for each of the number remaining. (This meaning is clearer in the *R-VJ* reading.) (We get the time of the day, in *kalās*, at the beginning of the *parva-nakṣatra*, that is, the Moon's *nakṣatra* at the new or full moon.) (*R-VJ* 11; *Y-VJ* 19)

Note 1. These *Kalās* are called *Bhā' dāna-kalāḥ*, to be understood in the context, from the reference to it in *Y-VJ* 17 and the work done in *Y-VJ* 21. (See Sn. V. 6, 9)

Example. Find the kalās at which the Moon's nakṣatra at the 93rd parva begins.

From the previous example, the *nakṣatra*-parts at *parva* is $93 = 11 \times 8$, plus 5, remainder. The *kalās* required $= 11 \times 19 - 73 \times 5 = 209 - 365$, which, counted from the beginning of the previous day is $(209 + 603)36 - 5 = 447$ of the previous day.

The above result can be verified thus: The time of the day when the 93rd *parva* ends is 62 parts (as found in Note 1 to verse *Y-VJ* 14, Sn. V. 3) which is $62 \times 603 \div 124 = 301\frac{1}{2}$ *kalās* of time. The Moon's *nakṣatra*-parts gone is 93. Since each *nakṣatra* takes 610 *kalās* to pass, to pass 93 it takes $93 \times 610 \div 124 = 457\frac{1}{2}$ *kalās*. So the *nakṣatra* begins at $457\frac{1}{2}$ *kalās* earlier than the $301\frac{1}{2}$ *kalās* of the day, which is $301\frac{1}{2} + 603 - 457\frac{1}{2} = 447$ *kalās* of the previous day.

To clinch the matter, in addition to this verification, a proof might also be given. After each period of 17 *parvas*, the Moon's *nakṣatras* increase by $17 \times 67 \times 27 \div 124 = 248 + 1/124$, which gives rise to one part. 248 *nakṣatras* take $248 \times 610 \div 603 = 250$ days $+ 530$ *kalās* $= 251$ days 73 *kalās*. This corresponds to one part. For 8 parts, it is $8 \times (-73) = -584 = 19$, neglecting whole days.

Note 2. This verification itself shows that the emendation of *dvi* into *tri* is necessary and correct. Tilak has mistaken the meaning of the word *udvapet* as 'putting in *or* adding', and made mistakes in his interpretation. *Āvāpa* means 'sowing *or* putting in', not *udvāpa* which mean 'taking out', *āvāpodvāpa* meaning 'putting in and taking out'. His interpretation will give an error of a few *kalās*, even after his unnecessary supplementation of this verse with verses *R-VJ* 12 (*Y-VJ* 27), *R-VJ* 13 and *Y-VJ* 16, (with several pages of explanation for this simple thing). This involved explanation itself must have told him that there is something wrong with his meaning, for he was transgressing his own dictum in his Introduction. His taking the 8 parts mentioned not as it is, but as 12 *parvas* (the origin of the 8 parts), has added to his difficulties.

'Rārhaspatya' has understood the meaning of *udvapet* correctly, but has made the same mistake in understanding *ūna* as he has done in *Y-VJ* 15 (Sn V. 4). He translates the second half as: "Introduce *minus* 72 *kalās* in place of the *subtrahend*", which does not yield any meaning. In his proof, he has done the first part correctly, but to prove the second part, he has arbitrarily taken '6 circuits of the Moon', just to get —72 *kalās* given in the text. So he has not been able to realise that it must be —73, not —72.

8. Tithi-Nakṣatra in the Jāvādi series

Text 31

tithim ekādaśābhyastām parvabhāṃśasamanvitām/
vibhajya bhasamūhena tithinakṣatram ādiśet// *Y-VJ* 20

> Multiply the *tithis* gone after a *parva* by 11, and adding it to the parts of the *nakṣatra* current at the end of the *parva*, and dividing out by the total number of *nakṣatras*, (viz. 27). Taking the remainder, and using it in the *Jāvādi* series, the *nakṣatra* current at the *tithi* must be found. (*Y-VJ* 20)

Example. Find the nakṣatra of the 8th tithi after the 93rd parva.

$8 \times 11 + 93$ parts (got for 93 parvas) $= 181$ (mod. 27)

Applying the *Jāvādi* series, the 19th, *Maghā*, is the *nakṣatra* of the 8th *tithi*.

Rough verification: Normally the Moon's *nakṣatra* increases one per day, as also the *tithi*. So the 8th after *Bharaṇī*, *Maghā* is the *nakṣatra* required here.

Explanation: The rule given here is just to get the *tithi-nakṣatra* by a reference to the *Jāvādi* series. In this series, the consecutive numbers are the same as the parts (mod. 27) of the *nakṣatra* given. The next *nakṣatra* occurs 11 places away. The *nakṣatra*

next to a given *nakṣatra* will occur 11 places off, because $11 \times 5\ 1/124 = 55\ 11/124 = 1\ 11/124$ (mod. 27). Now, roughly, successive *tithis* have successive *nakṣatras* (the difference being 17 *nakṣatra*-parts less for every 5 *tithis*). So, if the *tithis* are multiplied by 11 and added to the *parva-nakṣatra*-parts, we get the *nakṣatra* equal to the number of *tithis* after the *parva-nakṣatra* as the *nakṣatra* for that *tithi*. But, as mentioned above, the loss of 17 parts for every 5 *tithis* have to be subtracted from the parts of the *parva-nakṣatra* to get the actual parts of the *tithi-naksatra* and this may make the *tithi-nakṣatra* one less than what we get by this rule if the *parva*-parts are less than the correction.

Example. Find the naksatra of the end of 10 tithis after 36 parvas.

By *Y-VJ* 15, the *naksatra*-parts are 24 at *parva*. By this rule, $24 + 11 \times 10 = 134 = 26$ (mod. 27). The 26th in the *Jāvādi* is *Jyesṭhā*. But the correct *nakṣatra* is *Anūrādhā* 114 parts at the end of 10 *tithis*. It is got thus: The required *naksatra* and parts at *parva*=the *nakṣatra* and parts at *parva* (that is, Pusya 24 parts)+11 *nakṣatras*$-17 \times 10 \div 5$ (=34 parts)=*Anūrādhā* 114 parts.

Note 1. We can see that this rule has been given simply by a desire to use the *Jāvādi* for this purpose. Otherwise, the precise rule, which is easy, could have been given.

Tilak has got the idea correctly. But 'Bārhaspatya', missing the meaning, has given an involved formula, needing a more involved explanation. Sudhakara Dvivedi, thinking that the formula must give the *nakṣatra*-parts also correctly (the parts are not given in this rule) has made drastic emendations in his usual way, with *bhūta-saṅkhyā*, which could never have been used by the author.

9. Bhādānakalā

Text 32

yāḥ parvabhādānakalās tāsu saptaguṇāṃ tithim|
uktāḥ (?yuktyā) tāsām vijānīyāt tithibhādānikāḥ kalāḥ||R-VJ 21; *Y-VJ* 21

R-VJ reads the second half as:
prakṣipet kalā (?pettat) samūhas tu vidyād ādānakīḥ (?bhādānikāḥ) kalāḥ||

Adding *kalās* equal to seven times the *tithis* elapsed after the *parva*, to the *bhādānakalā* of the *parva* we get the *bhādānakalās* pertaining to the *tithis* (i.e. the times of the beginning of the *nakṣatras* current at the end of the *tithis*). (*R-VJ* 21; *Y-VJ* 21)

Note 1. The *tithi* here is loosely taken as equal to the day, though correctly it is 2 parts (about 10 *kalās*) less. Since the duration of the *nakṣatra* is 610 *kalās*,

that is, 7 *kalās* more than a day, the *nakṣatra* begins 7 *kalās* later each day or loosely each *tithi*. Hence the rule of adding 7 times the *tithis*.

Example. Find the beginning of the nakṣatra current at the end of the 8th tithi after the 93rd parva.

The beginning of the *nakṣatra* in question is 7×8=56 *kalās* later than the *parvabhādānakalās* got in the example in *Y-VJ* 19 (Sn. V. 7), viz. 447+56=503 *kalās* of the day previous to the 8th *tithi*.

10. Time of the Day : Position of the Sun

Text 33

atītaparvabhāgebhyaḥ śodhayed dviguṇāṃ tithim|
teṣu maṇḍalabhāgeṣu tithiniṣṭhāṃgato raviḥ||R-VJ 20; *Y-VJ* 22

> Subtract twice the number of *tithis* after a *parva* from the parts of the day ending the *parva*. We get the parts of the day when the *tithi* ends, (which is the same as the position of the Sun in the diurnal circle (technically) called *nāḍīmaṇḍala*) (divided into 124 parts). (*R-VJ* 20; *Y-VJ* 22)

Note 1. *Y-VJ* 25 and 26 which follow, (Sn. V. 11, 12), deal purely with the Sun. The present verse faces both ways, on one side giving the time of the day when the *tithi* ends and, on the other side, the position of the Sun in the sky, that is, in the diurnal circle at that time.

Example. What is the time of the day when the 8th tithi after the 93rd parva ends? Where is the Sun in the diurnal circle at that moment?

The time of the day=The time of the 93rd parva *minus* 8×2=62−16=46 parts of the day.

Dividing the diurnal circle into 124 parts, the Sun will be at the end of 46 parts counted from the east.

Note 2. 'Bārhaspatya', in his explanation, asks us to take for example, the Sun's diurnal position at *parva* to be 31. It can never be an odd number of parts. If he takes, as he does in his interpretation of *Y-VJ* 16 (Sn. V. 5), that the parts are reckoned for each quarter-day separately, how are we to know in which quarter-day the parts lie?

11. Sun's Nakṣatra at any time

Text 34

ekādaśabhir abhyasya parvāṇi navabhis tithim|
yugalabdham saparva syāt vartamānārkabham kramāt|| Y-VJ 25

Multiplying (the number of) *parvas* elapsed by 11 and the *tithis* elapsed after that by 9, (adding the two) and dividing (the total by the number of *parvas* in) the *yuga* (viz. 124), and taking the quotients and parts, and adding the number of the *parvas* to the quotient, we get the total number and parts of the Sun's *nakṣatra* which have elapsed, (counted from Śraviṣṭhā) in the regular order. (*Y-VJ* 25)

Example. Find the Sun's nakṣatra and parts at the end of the 8th tithi after the 93rd parva.

According to the rule, $(93\times 11+8\times 9)=8$ full *nakṣatras* and 103 parts. Adding 93 to the 8 full *nakṣatras* elapsed since and counting from *Śraviṣṭhā*, we have 101 *nakṣatras* and 103 parts in the next, i.e. the Sun is at the 103rd part of the 21st *nakṣatra*, *Viśākhā*, since $102=21$ (mod. 27).

Note 1. The *R-VJ* does not have this verse, perhaps feeling no need for the Sun's *nakṣatra*. Even in *Y-VJ* 15 (Sn. V. 4) the purpose is, perhaps, only to get the Moon's *nakṣatra* and parts, the Sun's *naksatra* and parts only coming by the way. We can get the Sun's *nakṣatras* and parts envisaged in this verse by simply multiplying the *tithis* elapsed by 9 parts and adding it to the Sun's *nakṣatra* already found. For instance, adding $8\times 9=72$ parts to *Viśākhā* 31 parts found in the example under *Y-VJ* 17-18 (Sn. V. 6), we get *Viśākhā* 103 parts, found in the example here.

Note 2. 'Bārhaspaty's' translation is defective, because *saparva* has been omitted. He says that the Sun's *nakṣatra* is got by this verse. Without adding the number of *parvas* as given by the expression *saparva*, the *nakṣatras* cannot be found because the whole *nakṣatra* per *parva* would be omitted taking only the parts. Also, his interpretation that two rules are given here, one for the *parva* and the other for the *tithi*, is also unnecessary, since the *parva-naksatra* can be found simply by taking the *tithi* elapsed after that as zero.

Tilak remarks that *yugalabdham* does not mean dividing by 124 parts, but simply adding the two results of the first half. He is wrong, because *saparva*, meaning to add whole *nakṣatras* elapsed, requires that the parts be converted into *nakṣatras*. In another context, he himself wants the division. Further, we are not told that the two results are parts, and so the instruction to divide by 124 is necessary.

12. DAY'S PARTS AT THE BEGINNING OF A NAKṢATRA

Text 35

sūryarkṣabhāgān navabhir vibhajya
śeṣaṃ dvirabhyasya dinopabhuktiḥ|
tithi(?the)r yutā bhuktidineṣu kālo
yogaṃ (?yogo) dinaikādaśakena tadvat|| Y-VJ 26

Divide the parts of the Sun's *nakṣatra* by 9. Multiply the remainder by 2. This is termed the partial complement for the day's parts. Add to this the complement for *tithis*, got as quotient, to obtain the total complement to be added to the day's parts. Add the total complement to the *nakṣatra*-parts and divide by 11. The result is the day before the completed day's parts when the *naksatra* began. (*Y-VJ* 26)

Example. The parts of the Sun's nakṣatra at the end of the 8th tithi after the 93rd parva is 103 of Viśākhā. The parts of the day when this tithi ends is 46 Find the day and parts when Viśākhā began.

Since 103/9=11 and 4/9, the partial complement is 8/9. The quotient being 11, the complement due to the *tithis* is 11×2=22. The total complement, i.e. 22 8/9, added to the parts of the day, viz. 46, is 46+22 8/9=68 8/9, and this is the completed parts of the day. Days for the 103 parts to pass=(103+22+8/9)÷11=11 4/9. So, *Viśākhā* began 11 4/9 days before the 68 8/9 parts of the day of the 8th *tithi*, i.e. 13 7/9 parts of the day of the 12th *tithi.*

Note 1. The translation given by me here, follows that suggested by Tilak, after examining the translations of Sudhakara and 'Bārhaspatya'. All agree in the final result. But Tilak's is a circumlocution because he wishes to use all the words in the verse. As it is, neglecting the last part, the rule can be given simply as: "Divide the Sun's *nakṣatra*-parts by 9. Double the 'result'. Add this to the *parts* of the day for which the *nakṣatra*-parts are given. The day and parts, when the *nakṣatra* began is the 'result' taken as days before the added parts of the given *tithi*-day."

In the example, 103 are the parts of the *nakṣatra* at 46 parts of the day of the 8th *tithi.* 103/9=11 4/9 is the 'result'. This doubled is 22 8/9. 46+22 8/9=68 8/9 are the increased parts of the day. The 'result' taken as days, i.e. 11 4/9 days, before 68 8/9 parts of the given (8th) *tithi*-day is 13 7/9 parts of the 12th *tithi*-day, as already found.

Note 2. The explanation of the rule is as follows: The *nakṣatra*-parts divided by 9 gives the *tithi* periods for the parts to go. But the number of *tithis* can be taken as the number of days if twice the number of *tithis*, taken as parts of a day, is sub-

tracted from it, because each *tithi* is two parts less than a day. But these days have to be subtracted from the given day and parts. So, twice the number of *tithis*, taken as parts, are added to the parts of the day and the number of *tithis*, taken as days, are subtracted from the point of the added parts of the day.

Note 3. It may be that some other rule is lurking in the last part where the division by 11 appears, not visible to us because of some corruption in this part.

13. Correction for the Sidereal Day

Text 36

tryaṃśo bhaśeṣo divasāṃśabhāgaś
caturdaśaś cāpyapanīya bhinnam|
bhārdhe 'dhike cāpi gate paro 'mśo
dvāv uttame tan navakair avedyaḥ (?tya)||R-VJ 12; *Y-VJ* 27

The excess in rising of the zodiac over the diurnal circle in terms of its 124th parts is a third of the number of days elapsed in the year, rounding off the fraction upto fourteen days in any *parva*. When (nearly) half a zodiac has been got as rise, add one more part, and, as the second half is (nearly) completed, add another one. This result can be obtained by extending the *navaka* rule (already given for the ending moments of the *parvas* in *Y-VJ* 16: Sn. V. 5). (*R-VJ* 12; *Y-VJ* 27)

Note 1. There are 367 risings of *Śraviṣṭhā* (or revolutions of the zodiac or sidereal days) in the year, while the civil days are 366. The defect in the sidereal day adds up to one sidereal day in the year, in which 124 parts of the zodiac rises. At the rate of one-third part daily, for 366 civil days there will be 122 parts rising, the two parts remaining being due to neglecting the fraction, viz. 2/366 each day. This neglect is taken into account by adding one part every half year, during which one-half of the zodiac, or one-half of the total *nakṣatras* in the zodiac, would have risen.

Note 2. The *navaka* rule already seen follows this verse according to the *R-VJ* recension. It occurs next to verse 15 of the *Y-VJ* version, as verse 16, because the manner of computation in both is the same. There the *tithi* or *parva* unit is used to find the time-angle of Śraviṣṭhā in daily parts and no neglected fraction is involved, but here the day-unit (so much part of the day) in used, and the fraction occurs. This will not matter, because, in actual practice, everything we got is only approximate or mean. In a note here, its extension to the *tithi* has been shown.

Example: Find the time-angle of Śraviṣṭha after 122 days in the year.

One-third of 122 is $40\frac{2}{3}$. For neglecting the fraction we may add 2/3, since we are asked to add one per half year, and make it $41\frac{1}{3}$ to be exact, though the rule here envisages only whole parts. Thus we have 41 parts.

14. Correction for the Yuga

Text 37

dvyū(?dyū)naṃ dviṣaṣṭibhāgena heyaṃ sauryāt sapārvanam/
yatkṛtāv upajāyete madhy 'nte cādhimāsakau//Y-VJ 37

The lunar day is less than the civil day by its 62nd part. The civil day is subtractable from the solar day (i.e. less than the latter). This defect, combined with the defect in the lunar day causes one extra month at the end of the half-*yuga* and another extra month at the end of the *yuga*. (*Y-VJ* 37)

Note 1. In the half-*yuga* there are 900 solar days, 915 civil days and 930 lunar days. So, in the one to one correspondence between the solar and the lunar months, one extra month has to be added at the end of each half-*yuga* to fit the lunar year reckoning with the solar year reckoning just as one more day is given to the civil year of 365 days to fit in with the correct year, once in four years, though even this is a little rough.

15. Ṛtuśeṣa (Tithis yet to Elapse in a Ṛtu)

Text 38

yadartham dinabhāgānaṃ sadā parvaṇi parvaṇi/
ṛtuśeṣaṃ tu tad vidyāt saṅkhyāya saha parvaṇām//R-VJ 23; *Y-VJ* 41

Adding all the half-*tithis* occurring after each *parva* of all the *parvas*, (that pass normally at the rate of 4 per *parva*), we get what is called *ṛtuśeṣa* (that is, the *tithis* which remain in the last *ṛtu* and have to be passed to complete it). (*R-VJ* 23; *Y-VJ* 41)

Note 1. While the last verse is required to know the number of *parvas*, the present verse gives the *ṛtuśesa*.

Example. (*i*) *Find the ṛtuśeṣa and* (*ii*) *how much is required after 93 parvas to complete the ṛtu*

(*i*) At 4 *parvas* per *ṛtu*, 23 *ṛtus* must have elasped at the end of 92 *parvas*, $92\times\frac{1}{2}=46$ *tithis* have to pass to complete the *ṛtu*.

(*ii*) At the end of 93 *parvas*, one *parva* of this *ṛtuśeṣa* has gone and 31 *tithis* (2 *parvas* and 1 *tithi*) remain to pass in the 23rd *ṛtu*, that is, in Śarad of the fourth year.

Verification: 23 *ṛtus* require actually $23 \times 124 \div 30 = 95$ *parvas* and 1 *tithi*. Since 93 *parvas* have elapsed, 2 *parvas* and 1 *tithi* remain to complete the *ṛtu*.

16. Day-time at any Parva

Text 39

yad uttarsyāyanato gataṃ syā-
che(?cche)ṣaṃ tathā dakṣinato 'yanasya/
tadek(?ka)ṣaṣṭyā dviguṇaṃ vibhaktaṃ
sadvādaśaṃ syād divasapramāṇaṃ//R-YV 22; *Y-VJ* 40

The number of days which have elapsed in the northward course of the Sun (*uttarāyaṇa*) or the remaining days in the southward course (*dakṣiṇāyana*) doubled and divided by 61, *plus* 12, is the day-time (in *muhūrtas*) of the day taken. (*R-VJ* 22; *Y-VJ* 40)

Example: Find the day-time at the end of (i) the 93rd parva and (ii) the 54th parva.

(*i*) Since there are 10 *ayanas* for the 124 *parvas* in the *yuga*, each *ayana* takes 12 *parvas* and 6 *tithis*. In 93 *parvas*, 7 full *ayanas* have elapsed and 6 *parvas* and 3 *tithis* have passed in the 8th *ayana*, which is a *dakṣiṇāyana*. $6 \times 15 + 3 = 93$ *tithis*, remain in this *ayana*. Since 1 *tithi* is day *minus* 2 parts, 93 *tithis* are $91\frac{1}{2}$ days. Therefore, the day-time by the given rule is: $(91\frac{1}{2} \times 2 \div 61) + 12 = 15$ *muhūrtas*. In fact, this is the autumnal equinox.

(*ii*) In 54 *parvas*, 4 *ayanas* have elapsed and in the 5th *ayana*, an *uttarāyaṇa*, 4 *parvas* and 6 *tithis* have also passed. Now, $4 \times 15 + 6 = 66$ *tithis* = 64 days. So the day-time is $(64 \times 2 \div 61) + 12 = 14\frac{6}{61}$ *muhūrtas* = 28 *nāḍīs* and 12 *vināḍīs*.

17. Upavasatha and Intercalary Days

Text 40

caturdaśīṃ upavasathas tathā bhavet
yathodito dinaṃ upaiti candramāḥ/
māghaśuklāhniko yuṅkte
śraviṣṭhāyāṃ ca vārṣikīṃ//R-VJ 34

That Caturdasi *tithi* on which the Moon rises just after the Sun has risen is the day of the *Upavasatha*. Any characteristic of the first day of the bright fortnight of the month of Māgha links the *nakṣatra* of the last day of the previous year (viz. Śravaṇa) with Śraviṣṭhā, (that is, it is common to both). (*R-VJ* 34).

Note 1. This verse is not found in the *Y-VJ.*

Note 2. Upavasatha day is the day of which the previous day is the *ādhāna* or *dīkṣā* day, that day itself is the *piṇḍapitṛyajña* day and the next day is the *iṣṭi* day.

Note 3. The Moon rising just after sunrise indicates that the time is near new moon. By contrast, if the Moon rises before sunrise, and becomes what is technically called *Ud-dṛṣṭa* all excepting the Vājasaneyins and Baudhāyanas have to perform an expiatory rite to nullify the evil that will acrue and perform *punarādhāna* if the *ādhāna* had been done on the previous day. The next day will be the *upavasatha* and the next the *iṣṭi* day. This shows how careful the priests would have been to avoid such a thing happening and, naturally, they must have had rules, formed from long observation, to fix the religious calendar tolerably well, using the system of the *Vedāṅga Jyotiṣa* as framework.

Note 4. The second half of the verse suggests how the conditions of the first half can arise. On account of the lunar year being shorter by 11 days, and this accumulating to almost one month before intercalation is made, the *nakṣatra* of the first day of Māgha can be Śravaṇa or even Uttarāṣāḍha. Even at the end of the *yuga*, the new *yuga* can begin with part of Śravana, because actually the 62 lunar months of the *yuga* take 1830.8965 days, not 1830 days, as the latter has been adopted just for civil convenience. Therefore, all the characteristics like *naksatra* and its endings will apply better to the first day of the next *yuga*. This will vitiate the characteristics of all the days of the next *yuga* and also accumulate *yuga* after *yuga*. Thus, the civil calendar will wander farther and farther away from the religious calendar. This can be avoided if the day next to the 1830 days of the *yuga* is not reckoned and the next day to that is taken as the first day of the new *yuga*, In fact, this day will be an intercalary day made at the end of each *yuga*. It is this that is suggested by the second half of the verse.

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VERSE (PĀDA) INDEX

[*Note* The entries are arranged in the Sanskrit alphabetical order. Both the Ṛk and Yajus recensions, with variants, of the work are included in the Index and are indicated, respectively, by R and Y. The references are to verse numbers and *pādas*, a, b, c, d, of the Critical texts edited in Pt A The occurrence of the verses in Pt. B is indicated by the Section numbers (i to v) and Topic numbers therein Citations in the Introduction have been indexed with the prefix 'Intro.' and from the footnotes with the prefix 'intro fn.'.]

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[*Note* The refeiences are to Section numbers and not to pages. Those from the Introduction are prefixed by 'Intro ' and those from Part B—Translation and Notes by the Sections (i to v) and the Topics therein.]

Idāvatsara, Intro. § 1; ii. 1; iv 7

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